

PUMP, PUMP DEVICE, DISPENSING HEAD, DISPENSING HEAD ARRAY AND DISPENSING DEVICE**Patenttinumero:** JP2003343426 (A)**Julkaisupäivä:** 2003-12-03**Keksijä(t):** ITANI KAZUNORI**Hakija(t):** ALOKA CO LTD**Patenttiluokitus**

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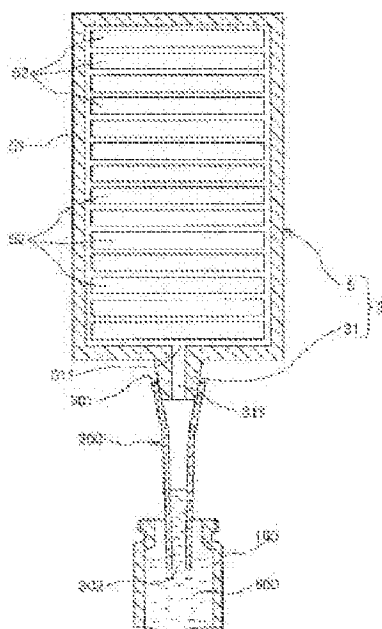
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PROBLEM TO BE SOLVED: To provide a pump, a pump device, a dispensing head, a dispensing head array and a dispensing device capable of sucking and discharging a fluid with a simple structure and with high accuracy.



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CLAIMS

[Claim(s)]

[Claim 1]A pump characterized for a fluid by inhalation / carrying out the regurgitation from said outflow/entrance by having the following, carrying out release of energization to said energized part, or energization, and changing volume of said volume variable member.

Housing in which an outflow / outflow which carries out ON / entrance was formed for a fluid.

At least one volume variable member which comprised a substance from which volume changes by being installed in said housing and impressing voltage or a magnetic field.

An energized part which impresses voltage or a magnetic field to said volume variable member by energization.

[Claim 2]The pump according to claim 1 in which said fluid is a working fluid.

[Claim 3]The pump according to claim 1 or 2 with which said volume variable member comprises piezoelectric material or a magnetostrictive material.

[Claim 4]The pump according to any one of claims 1 to 3 which has said two or more volume variable members.

[Claim 5]The pump according to claim 4 which said two or more volume variable members make tabular, respectively, leaves a crevice in the thickness direction, and is arranged in piles.

[Claim 6]Said energized part is individually provided to said each volume variable member, respectively, and it is the pump according to claim 4 or 5 which can impress voltage or a magnetic field independently, respectively to said each volume variable member.

[Claim 7]The pump according to any one of claims 1 to 6 with which said housing is making cylindrical shape mostly.

[Claim 8]The pump according to any one of claims 1 to 6 which is making shape with said flat housing.

[Claim 9]A pumping plant comprising:

The pump according to any one of claims 1 to 8.

A pump control means which controls an operation of said pump.

[Claim 10]By adjusting energizing voltage to said energized part, it is the pumping plant according to claim 9 which can adjust inhalation/discharge quantity of a fluid.

[Claim 11]Said pump has said two or more volume variable members and said energized part individually provided to each volume variable member, respectively, It is the pumping plant according to claim 9 or 10 which can adjust inhalation/discharge quantity of a fluid by adjusting the number of said energized part which can impress voltage or a magnetic field independently to said each volume variable member, respectively, and carries out release of energization or energization.

[Claim 12]Said pump has said two or more volume variable members and said energized part individually provided to each volume variable member, respectively, The pumping plant according to any one of claims 9 to 11 which sets a time lag to each energized part, and performs release of energization or energization when voltage or a magnetic field can be independently impressed to said

each volume variable member, respectively and release of energization or energization is carried out to said two or more energized parts.

[Claim 13]By adjusting said time lag, it is the pumping plant according to claim 12 which can adjust inhalation/discharge velocity of a fluid.

[Claim 14]A distributive-pouring head which is provided with the following and characterized for a fluid by inhalation / carrying out the regurgitation and pouring a fluid distributively from a tip opening of said nozzle by the operation of said pump.

The pump according to any one of claims 1 to 8.

It is a nozzle applied part which can equip with a nozzle so that it may be open for free passage at said outflow/entrance of said pump.

[Claim 15]A distributive-pouring head array which installs two or more distributive-pouring heads according to claim 14 side by side, and is characterized by things.

[Claim 16]The distributive-pouring head array according to claim 15 which said each distributive-pouring head is making flat shape, and installs said two or more distributive-pouring heads in the thickness direction side by side.

[Claim 17]A distributive-pouring device having at least one of the pumping plants according to any one of claims 9 to 13 as a suction means.

[Claim 18]A distributive-pouring device provided with at least one distributive-pouring head according to claim 14.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to a pump, a pumping plant, a distributive-pouring head, a distributive-pouring head array, and a distributive-pouring device.

[0002]

[Description of the Prior Art]For example, the distributive-pouring device which does classification of a little fluids, such as a sample and a reagent, dilution, mixing, dropping work, etc. is known. This distributive-pouring device is used, for example in the field of a clinical laboratory test, the field of a fundamental research, etc.

[0003]The distributive-pouring head in the conventional distributive-pouring device is provided with the syringe which has a piston which slides within a tube-like object and this tube-like object, the piston moving mechanism to which a piston is moved, and the nozzle which is open for free passage in a syringe. And inhalation and the regurgitation carry out a fluid from the tip opening of a nozzle by moving a piston and changing the pressure in a syringe according to a piston moving mechanism.

[0004]However, in the conventional distributive-pouring head, since the mechanical piston moving mechanism which used the feed screw etc., for example was needed, there was a problem that structure was complicated and a manufacturing cost was high.

[0005]It was difficult to improve the accuracy of the amount of distributive pouring by the mechanical backlash of a piston moving mechanism, a backlash, etc., since the precision improvement of the position control of a piston is difficult. In particular, a little fluids were not able to be poured distributively in high accuracy.

[0006]Since a piston moving mechanism was what performs mechanical operation, it was comparatively apt to cause failure and inferior also to endurance.

[0007]

[Problem(s) to be Solved by the Invention]The purpose of this invention is an easy structure and there is in providing the pump, the pumping plant, distributive-pouring head and distributive-pouring head array which can perform inhalation and the regurgitation of a fluid in high accuracy, and a distributive-pouring device.

[0008]

[Means for Solving the Problem]Such a purpose is attained by this invention of following the (1) - (18).

[0009](1) By at least one volume variable member which comprised a substance from which volume changes by installing a fluid in housing in which an outflow / outflow which carries out ON / entrance was formed, and said housing, and impressing voltage or a magnetic field, and energization. A pump characterized for a fluid by inhalation / carrying out the regurgitation from said outflow/entrance by having an energized part which impresses voltage or a magnetic field to said volume variable member, carrying out release of energization to said energized part, or energization, and changing volume of said volume variable member.

[0010](2) A pump given in the above (1) in which said fluid is a working fluid.

[0011](3) A pump the above (1) by which said volume variable member is constituted from piezoelectric material or a magnetostrictive material, or given in (2).

[0012](4) A pump the above (1) which has said two or more volume variable members thru/or given in either of (3).

[0013](5) A pump given in the above (4) which said two or more volume variable members make tabular, respectively, leaves a crevice in the thickness direction, and is arranged in piles.

[0014](6) Said energized part is individually provided to said each volume variable member, respectively, and it is a pump the above (4) which can impress voltage or a magnetic field independently, respectively, or given in (5) to said each volume variable member.

[0015](7) A pump the above (1) for which said housing is making cylindrical shape mostly thru/or given in either of (6).

[0016](8) A pump the above (1) which is making shape with said flat housing thru/or given in either of (6).

[0017](9) A pumping plant having a pump of a statement, and a pump control means which controls an operation of said pump in the above (1) thru/or either of (8).

[0018](10) By adjusting energizing voltage to said energized part, it is a pumping plant given in the above (9) which can adjust inhalation/discharge quantity of a fluid.

[0019](11) Said pump has said two or more volume variable members and said energized part individually provided to each volume variable member, respectively, A pumping plant of the above (9) which can adjust inhalation/discharge quantity of a fluid or a statement to (10) by what the number of said energized part which can impress voltage or a magnetic field

independently to said each volume variable member, respectively, and carries out release of energization or energization is adjusted for.

[0020](12) Said pump has said two or more volume variable members and said energized part individually provided to each volume variable member, respectively, A pumping plant the above (9) which sets a time lag to each energized part, and performs release of energization or energization when voltage or a magnetic field can be independently impressed to said each volume variable member, respectively and release of energization or energization is carried out to said two or more energized parts thru/or given in either of (11).

[0021](13) By adjusting said time lag, it is a pumping plant given in the above (12) which can adjust inhalation/discharge velocity of a fluid.

[0022](14) Have a nozzle applied part which can equip with a nozzle so that it may be open for free passage at said outflow/entrance of a pump the above (1) thru/or given in either of (8), and said pump, and by the operation of said pump. A distributive-pouring head characterized for a fluid by inhalation / carrying out the regurgitation and pouring a fluid distributively from a tip opening of said nozzle.

[0023](15) A distributive-pouring head array which installs two or more distributive-pouring heads of a statement in the above (14) side by side, and is characterized by things.

[0024](16) A distributive-pouring head array given in the above (15) which said each distributive-pouring head is making flat shape, and installs said two or more distributive-pouring heads in the thickness direction side by side.

[0025](17) A distributive-pouring device equipping the above (9) thru/or either of (13) with a pumping plant of a statement at least one as a suction means.

[0026](18) A distributive-pouring device equipping the above (14) with at least one distributive-pouring head of a statement.

[0027]

[Embodiment of the Invention]Hereafter, the pump of this invention, a pumping plant, a distributive-pouring head, a distributive-pouring head array, and a distributive-pouring device are explained in detail based on the suitable embodiment shown in an accompanying drawing.

[0028]The perspective view showing the volume variable member in the distributive-pouring head which shows drawing 2 drawing of longitudinal section showing the distributive-pouring head and nozzle in the distributive-pouring device which shows drawing 1 the perspective view in which drawing 1 shows the embodiment of the distributive-pouring device of this invention, and drawing 2, and drawing 3, and drawing 4 are the block diagrams of the distributive-pouring device shown in drawing 1.

[0029]As shown in drawing 1, the distributive-pouring device 1 is provided with the following.
Device main frame 2.

Distributive-pouring head 3.

Distributive-pouring head transportation device 4.

The distributive-pouring device 1 is provided with the pumping plant 6 of this invention as a suction means. This distributive-pouring device 1 is inhalation and a thing which carries out the regurgitation and does classification of the fluid 500, dilution, mixing, dropping work, etc. about the fluids 500, such as a drug solution and a sample, from the tip opening 302 of the nozzle 300 with which the distributive-pouring head 3 was equipped with the suction force which the pump 5 which the pumping plant 6 has generates.

[0030]The device main frame 2 has the stage 21. On the stage 21, the reagent vessel stowage 22, the reaction vessel stowage 23, and the nozzle stowage 24 are formed, respectively. In the reagent vessel stowage 22, can store two or more reagent vessels 100 which store a drug solution (charge), and to it in the reaction vessel stowage 23. Two or more reaction vessels 200 which store reaction mixture can be stored (charge), and two or more nozzles 300 for exchange can be stored in the nozzle stowage 24 (charge).

[0031]As shown in drawing 2, the distributive-pouring head 3 is provided with the following. The pump 5 of this invention.

The nozzle applied part 31 which can equip with the nozzle 300.

Hereafter, the composition of this distributive-pouring head 3 is explained.

[0032]The pump 5 is provided with the following.

Housing 51.

Two or more volume variable members 52 installed in the housing 51.

The energized part 53 which impresses voltage to the volume variable member 52 by energization.

[0033]The housing 51 is a case which makes cylindrical shape mostly. This housing 51 comprises material with various metallic materials, ceramics, a hard resin material, etc. hard, for example, and has become a rigid body which is not expanded and contracted substantially.

[0034]The air (gas) as a working fluid flows into the pars basilaris ossis occipitalis of the housing 51, and the outflow entrance 511 which carries out ON is formed in it. The seal of the portions other than outflow entrance 511 of the housing 51 is carried out so that it may not let a fluid pass, and airtightness (fluid-tight nature) is secured.

[0035]The volume variable member [two or more (the composition of a graphic display 14 pieces)] 52 is installed in the building envelope of the housing 51. These volume variable members 52 are the same composition mutually, and are making disc-like, respectively.

[0036]The volume variable member 52 comprises a substance from which volume changes by impressing voltage (electric field). Especially as such a substance, although not limited, piezoelectric material, such as crystal (SiO_2), lithium niobate, barium titanate, lead titanate,

lead zirconate titanate (PZT), a lead metaniobate, and polyvinylidene fluoride (PVDF), is mentioned, for example.

[0037]As shown in drawing 3, to each volume variable member 52, the energized part 53 is formed individually, respectively. The energized part 53 comprises the laminated electrodes 531 and 532 and the leads (signal wire) 533 and 533 connected to the electrodes 531 and 532, respectively. The electrode 531 is contacted and formed in one field of the volume variable member 52, and the electrode 532 is contacted and formed in the field of another side of the volume variable member 52. The leads 533 and 533 are electrically connected to the pump drive circuit 12 provided outside, respectively. In drawing 2, the graphic display of the electrodes 531 and 532 and the lead 533 is omitted.

[0038]As shown in drawing 2, two or more disc-like members which consist of the volume variable member 52 and the electrodes 531 and 532 leave the crevice into which a fluid may invade, and are arranged mostly in piles at equal intervals in the thickness direction. By such arrangement, two or more volume variable members 52 can be efficiently arranged to the space in the housing 51, and it contributes to the miniaturization of the pump 5.

[0039]The supporting structure within the housing 51 of the disc-like member which consists of the volume variable member 52 and the electrodes 531 and 532 can be made into the supporting structure using the spacer which what kind of thing may be sufficient as, for example, is not illustrated. This supporting structure is the structure which can free modification which each volume variable member 52 mentions later.

[0040]As shown in drawing 4, it is connected to the control section (CPU) 11, and the pump drive circuit 12 is energized to the energized part 53 based on the control signal from the control section 11. The control section 11 controls the operation of the pump 5 like the after-mentioned based on the application program for controlling the pump 5 stored in the storage parts store 18, and the input data inputted from the input part 19. The pump control means 13 which controls the operation of the pump 5 comprises the control section 11, the pump drive circuit 12, the storage parts store 18, and the input part 19.

[0041]If it energizes to the energized part 53, the voltage (electric field) produced between the electrode 531 and the electrode 532 will be impressed to the volume variable member 52. According to the piezo-electric effect, it will elongate to the thickness direction and the volume variable member 52 will be contracted to a diametral direction, if voltage is impressed. And if impression of voltage is canceled, the volume variable member 52 will return to the original shape.

[0042]When the volume of the volume variable member 52 before and after such modification is measured, the volume of the volume variable member 52 in the state where voltage was impressed is slightly larger than the volume in the state where voltage is not impressed. That is, if the volume variable member 52 impresses voltage, volume will increase, and if

impression of voltage is canceled, volume will decrease.

[0043]Since the capacity of the left-behind space (space which is not occupied by volume variable member 52 grade) in the housing 51 will decrease if the volume of the volume variable member 52 increases, the air in the housing 51 flows out and it flows out from the entrance 511. On the contrary, since the capacity of the left-behind space in the housing 51 will increase if the volume of the volume variable member 52 decreases, air flows out and it flows in the housing 51 from the entrance 511. Thus, as for the pump 5, inhalation and the regurgitation carry out air from the outflow entrance 511.

[0044]The pumping plant 6 of this invention comprises such a pump 5 and the pump control means 13 (refer to drawing 4).

[0045]As shown in drawing 2, the nozzle applied part 31 is formed in the pump 5 bottom. The channel 311 which is open for free passage at the outflow entrance 511 is formed in the inside of the nozzle applied part 31. If the nozzle applied part 31 is equipped with the nozzle 300, the lumen of the nozzle 300 will flow out via the channel 311, and will be open for free passage at the entrance 511 (inside of the housing 51).

[0046]The portion by the side of the lower end of the nozzle applied part 31 is the tapered shape which an outer diameter dwindle toward down. When this tapered shape portion inserts without a crevice and fits in in the end face opening 301 of the nozzle 300, the nozzle 300 is fixed in airtight to the nozzle applied part 31, enabling free attachment and detachment. the nozzle 300 comprises various resin materials etc. preferably, for example -- being disposable (throwing away) -- it has become.

[0047]When pouring a different fluid distributively, contamination can be prevented by exchanging the nozzle 300. As for exchange of the nozzle 300, it is preferred that the nozzle replacement mechanism in which make it move to the nozzle stowage 24, and the distributive-pouring head 3 is not illustrated can perform now automatically.

[0048]It may be what it may be equipped with the nozzle 300 by screwing in this invention not only to composition like a graphic display but to the nozzle applied part 31, enabling free attachment and detachment, and the nozzle 300 cannot detach and attach to the distributive-pouring head 3.

[0049]As shown in drawing 1, the distributive-pouring head transportation device 4 is provided with the following.

The rising and falling mechanism 41 which supports the distributive-pouring head 3 which was explained above movable in the perpendicular direction (Z shaft orientations).

Y axial movement mechanism 42 which moves the rising and falling mechanism 41 horizontally (Y shaft orientations).

X axial movement mechanism 43 which moves Y axial movement mechanism 42 to a horizontal direction (X axial direction) vertical to a Y-axis.

By such composition, the distributive-pouring head transportation device 4 can move the distributive-pouring head 3 now in the direction of a three dimension on the stage 21.

[0050]The operation of the distributive-pouring head transportation device 4 is controlled by the control section 11 based on the application program for controlling the distributive-pouring head transportation device 4 stored in the storage parts store 18, and the input data inputted from the input part 19.

[0051]The rising and falling mechanism 41, Y axial movement mechanism 42, and X axial movement mechanism 43 can be used as the arbitrary mechanisms which the mechanism of what kind of structure may be sufficient as, for example, used a feed screw, a rack & pinion gear, a servo motor, a fluid pressure cylinder, etc.

[0052]Such a distributive-pouring device 1 does the distributive-pouring work of classification of the fluid 500, dilution, mixing, dropping, etc., moving the distributive-pouring head 3 between each reagent vessel 100 and each reaction vessel 200 by the operation of the distributive-pouring head transportation device 4.

[0053]Hereafter, the case where the fluid 500 in the reagent vessel 100 is classified for the operation of the distributive-pouring device 1 to the reaction vessel 200 is explained to an example.

[0054][1] The tip opening 302 of the nozzle 300 energizes on predetermined voltage to all the energized parts 53 by the state of being in the air, first. All the volume variable members 52 will be increased by volume by this.

[0055][2] Rank second, operate the distributive-pouring head transportation device 4, and move the distributive-pouring head 3 so that the tip opening 302 of the nozzle 300 may be located below the oil level of the fluid 500 in the reagent vessel 100.

[0056][3] In this state, if the energization to the energized part 53 is canceled, when the volume of the volume variable member 52 decreases, the air in the nozzle 300 will flow out, it will be inhaled in the housing 51 from the entrance 511, and the pressure in the nozzle 300 will decline. The fluid 500 is inhaled in the nozzle 300 from the tip opening 302 by this failure of pressure (refer to drawing 2).

[0057]At this time, the quantity of the fluid 500 inhaled in the nozzle 300 can be adjusted by adjusting the number of the energized part 53 which cancels energization. That is, when the number of the energized part 53 which cancels energization is one piece, the fluid 500 of the quantity corresponding to the amount of volume decreases of the one volume variable member 52 is inhaled in the nozzle 300. And the suction quantity of the fluid 500 will be the 2 and 3, ..., 14 times in general to the time of canceling energization of the one energized part 53 by considering it as two pieces, three pieces, ..., the 14 number of the energized part 53 which cancels energization. Thus, the suction quantity of the fluid 500 can be adjusted to 14 steps.

[0058]When it is a thing of the character in which volume does not return to the original size

(size of a standard) thoroughly at this time even if the volume variable member 52 makes impressed electromotive force zero, That is, when it is what has a hysteresis in the volume change of the volume variable member 52, after canceling the energization to the energized part 53, it is good also as performing control which impresses the voltage of an opposite direction to the energized part 53 so that the volume of the volume variable member 52 may return to the size of a standard. The fixed reference voltage in the energized part 53 is impressed in front of the above [1], Voltage higher than this can be impressed to the energized part 53 by [1], control of returning the impressed electromotive force to the energized part 53 to said reference voltage by [3] may be carried out, and influence of a hysteresis can be made small by this control. Higher-precision distributive pouring can be performed by performing these control [like]. In this specification, as mentioned above, after canceling the energization to the energized part 53, it is only called "release of energization" also including the case where the voltage of an opposite direction is impressed, and the case where the impressed electromotive force to the energized part 53 is returned to a certain fixed reference voltage. [0059]In inhalation operation of such a fluid 500, if the energization to those energized parts 53 is simultaneously canceled when canceling the energization to two or more energized parts 53, the fluid 500 can be inhaled at high speed.

[0060]When canceling the energization to two or more energized parts 53, a time lag may be set to each energized part 53, and energization may be canceled. In this case, the suction speed of the fluid 500 can be adjusted by adjusting that time lag. That is, if the time lag is lengthened, suction speed can be made late, and suction speed can be made quick if the time lag is shortened.

[0061][4] If the fluid 500 is inhaled in the nozzle 300, the distributive-pouring head transportation device 4 will be operated, and the distributive-pouring head 3 will be moved to the position of the reaction vessel 200.

[0062][5] Rank second and energize on predetermined voltage again to the energized part 53 which canceled energization. The volume of the energized volume variable member 52 increases by this, the air in the housing 51 flows out, it flows out of the entrance 511, and the pressure in the nozzle 300 increases. The regurgitation (discharge) of the fluid 500 in the nozzle 300 is carried out from the tip opening 302 by this pressure increase. By making this breathed-out fluid 500 dropped at the reaction vessel 200 (fall), it gives into the reaction vessel 200. When adhered to the tip opening 302 neighborhood by the breathed-out fluid 500, It is better also as giving the breathed-out fluid 500 into the reaction vessel 200 than operate the distributive-pouring head transportation device 4 and contacting the tip part of the nozzle 300 into the wall of the reaction vessel 200, or the fluid in it.

[0063]In the case of such discharging of the fluid 500, the quantity of the fluid 500 which carries out the regurgitation can be adjusted by adjusting the number of the energized part 53

to energize like the time of the aforementioned inhalation operation.

[0064]If it energizes simultaneously to those energized parts 53 when energizing to two or more energized parts 53 in discharging of such a fluid 500, the regurgitation of the fluid 500 can be carried out at high speed. Depending on conditions, such as discharge quantity and an opening diameter of the tip opening 302, from the nozzle 300, as the fluid 500 is injected, the regurgitation can also be carried out.

[0065]When energizing to two or more energized parts 53 in discharging of the fluid 500, a time lag may be set and energized to each energized part 53. In this case, the discharge velocity of the fluid 500 can be adjusted by adjusting that time lag. That is, if the time lag is lengthened, discharge velocity can be made late, and discharge velocity can be made quick if the time lag is shortened.

[0066][6] By moving the distributive-pouring head 3 to other reaction vessels 200, and repeating operation of [5], the fluid 500 in the reagent vessel 100 is classifiable to each reaction vessel 200.

[0067]Thus, by the volume change of the volume variable member 52, in a fluid, the regurgitation is carried out and the pump 5 of this invention does not have [inhalation and] a mechanical flexible region. Therefore, since adverse effects, such as mechanical backlash and a backlash, are not received, suction quantity and discharge quantity are controllable by high accuracy (adjustment). In particular, in high accuracy, it can inhale and the regurgitation also of very little fluids can be carried out. Structure is easy and contributes also to reduction of a manufacturing cost. Since there is no flexible region, there is little fear of failure and it is excellent also in endurance.

[0068]In the distributive-pouring head 3 and the distributive-pouring device 1 of this invention provided with such a pump 5 (pumping plant 6), the amount of distributive pouring can be controlled by high accuracy (adjustment), and very little fluids can also be especially poured distributively in high accuracy.

[0069]In this embodiment, the energized part 53 is individually formed to two or more volume variable members 52, respectively, and when impression has become possible about voltage independently to each volume variable member 52, respectively, suction quantity and discharge quantity can be adjusted easily and with high precision. In this invention, when forming two or more volume variable members 52, the number in particular is not limited, for example, can be made into about 2-1000 pieces. By increasing the number of the volume variable member 52, suction quantity and discharge quantity can be adjusted more broadly from a minute amount to comparatively large quantity, and with high precision.

[0070]The setting number of the volume variable member 52 seems to have become settled in the value predetermined in suction quantity and discharge quantity in this invention at one piece. Even when the number of the volume variable members 52 is one, by adjusting the

energizing voltage to the energized part 53, the amount of volume changes of the volume variable member 52 can be adjusted, and, thereby, suction quantity and discharge quantity can also be adjusted.

[0071]Also when two or more volume variable members 52 are installed, it may be made to adjust the energizing voltage to the energized part 53. Thereby, suction quantity and discharge quantity can be adjusted with the more sufficient accuracy on a multi stage story.

[0072]Volume seems to decrease by impression of voltage in this invention to the embodiment and reverse which the volume variable member 52 mentioned above.

[0073]Although the target fluid 500 was poured distributively inhalation and by carrying out the regurgitation by using air (gas) as a working fluid in this embodiment, an insulating fluid may be sufficient as a working fluid in this invention. That is, it fills up with an insulating liquid in the housing 51, and the fluid 500 may be poured distributively via inhalation and the insulating liquid which carries out the regurgitation from the outflow entrance 511. When an insulating tunic is formed in the volume variable member 52 and the surface of the energized part 53, a fluid without insulation may be sufficient as a working fluid.

[0074]A volume variable member may be constituted from this invention by impression of a magnetic field by the substance from which volume changes (magnetostrictive effects). Especially as such a substance, although not limited, various magnetostrictive materials, such as a Tb-Dy-Fe alloy, a super magnetostriction material, etc. are mentioned, for example. In this case, as an energized part, the coil which impresses a magnetic field to this volume variable member by energization can be used, for example.

[0075]Drawing 5 is a perspective view showing the embodiment of the distributive-pouring head array of this invention. Hereafter, although the embodiment of the distributive-pouring head array of this invention is described with reference to this figure, it explains focusing on a point of difference with the embodiment mentioned above, and the same matter omits that explanation.

[0076]The distributive-pouring head array 7 shown in drawing 5 installs the distributive-pouring head [two or more (the composition of a graphic display 16 pieces)] 71 side by side. The distributive-pouring head 71 is the same as said distributive-pouring head 3 except the shape differing.

[0077]The housing 711 of the pump in the distributive-pouring head 71 is making flat rectangular parallelepiped shape. In the housing 711, the tabular volume variable member with long and slender plurality (large number) is arranged in piles.

[0078]The distributive-pouring head array 7 installs two or more such thin distributive-pouring heads 71 in the thickness direction side by side at a single tier. Since the mechanical driving source is an easy unnecessary structure, the pump of this invention has the high flexibility of shape. Therefore, such a thin distributive-pouring head 71 and the small distributive-pouring

head array 7 of an array pitch are easily realizable.

[0079]When pouring distributively to the microplate (multi-hole plate) which can be poured distributively at once to two or more places for example, by which many holes were formed in matrix form according to the distributive-pouring device provided with such a distributive-pouring head array 7, it can pour distributively promptly at very high efficiency.

[0080]Drawing 6 is drawing of longitudinal section showing other embodiments of the pump of this invention. Hereafter, although other embodiments of the pump of this invention are described with reference to this figure, it explains focusing on a point of difference with the embodiment mentioned above, and the same matter omits that explanation.

[0081]Pump 5' of this embodiment sends out a fluid toward right-hand side from the left-hand side in drawing 6. This pump 5' is applicable to other devices of various kinds of which send out not only a distributive-pouring device but a fluid.

[0082]Pump 5' is provided with the following.

It has the almost same composition as said pump 5, and is housing 51'.

Two or more volume variable members 52 installed in housing 51'.

The energized part 53 which impresses voltage to the volume variable member 52 by energization.

[0083]The input 512 where a fluid flows, and the tap hole 513 where a fluid flows out are established in housing 51', respectively. That is, in this embodiment, the input 512 and the tap hole 513 are separately formed in housing 51'. In the middle of the channel 14 connected to the input 512, the check valve (check valve) 16 is formed and the check valve (check valve) 17 is formed in the middle of the channel 15 connected to the tap hole 513.

[0084]If pump 5' operates like the above, pump 5' will inhale a fluid from the input 512, and will carry out the regurgitation of the fluid from the tap hole 513. Thereby, the fluid in the channel 14 and 15 can be sent out rightward in drawing 6.

[0085]That is, although said pumps 5 were inhalation and a thing which carries out the regurgitation about the target fluid 500 via the air (gas) which is a working fluid, directly, it inhales and breathes out and pump 5' of this embodiment sends out the target fluid.

[0086]As a fluid which pump 5' sends out, a fluid or a gas may be sufficient. In the case of a fluid, it is preferred that the insulating tunic is formed in the volume variable member 52 and the surface of the energized part 53.

[0087]Although there may not be the check valves 16 and 17, it is preferred that at least one side of the check valves 16 and 17 is provided.

[0088]As mentioned above, although the embodiment of the graphic display of the pump, the pumping plant, the distributive-pouring head, distributive-pouring head array, and distributive-pouring device of this invention was described, This invention is not limited to this and each

part which constitutes a pump, a pumping plant, a distributive-pouring head, a distributive-pouring head array, and a distributive-pouring device can be replaced by the thing of arbitrary composition of that the same function can be exhibited. Arbitrary structures may be added.

[0089]Although this invention is applicable from what has 1 time of comparatively large inhalation / discharge quantity to a very small quantity thing, 1 time of inhalation/discharge quantity are suitable for it to the minute amount thing which is about 1 nano liter -100 microliter especially.

[0090]The thing of what kind of shape, such as not only a tabular thing but rod form, block like shape, etc., may be sufficient as a volume variable member. What kind of thing may be sufficient also as the modification mode of a volume variable member when voltage or a magnetic field is impressed.

[0091]

[Effect of the Invention]As stated above, according to this invention, with high accuracy, the regurgitation can be carried out and inhalation and the regurgitation can carry out a fluid in inhalation and the accuracy in which a little fluids are also especially expensive.

[0092]The above-mentioned effect can be attained with an easy structure, and it contributes also to reduction of a manufacturing cost. There is little fear of failure and it is excellent also in endurance. Inhalation and the regurgitation can make a fluid high-speed.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention]This invention relates to a pump, a pumping plant, a distributive-pouring head, a distributive-pouring head array, and a distributive-pouring device.

[Translation done.]

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PRIOR ART

[Description of the Prior Art]For example, the distributive-pouring device which does classification of a little fluids, such as a sample and a reagent, dilution, mixing, dropping work, etc. is known. This distributive-pouring device is used, for example in the field of a clinical laboratory test, the field of a fundamental research, etc.

[0003]The distributive-pouring head in the conventional distributive-pouring device is provided with the syringe which has a piston which slides within a tube-like object and this tube-like object, the piston moving mechanism to which a piston is moved, and the nozzle which is open for free passage in a syringe. And inhalation and the regurgitation carry out a fluid from the tip opening of a nozzle by moving a piston and changing the pressure in a syringe according to a piston moving mechanism.

[0004]However, in the conventional distributive-pouring head, since the mechanical piston moving mechanism which used the feed screw etc., for example was needed, there was a problem that structure was complicated and a manufacturing cost was high.

[0005]It was difficult to improve the accuracy of the amount of distributive pouring by the mechanical backlash of a piston moving mechanism, a backlash, etc., since the precision improvement of the position control of a piston is difficult. In particular, a little fluids were not able to be poured distributively in high accuracy.

[0006]Since a piston moving mechanism was what performs mechanical operation, it was comparatively apt to cause failure and inferior also to endurance.

[0007]

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EFFECT OF THE INVENTION

[Effect of the Invention]As stated above, according to this invention, with high accuracy, the regurgitation can be carried out and inhalation and the regurgitation can carry out a fluid in inhalation and the accuracy in which a little fluids are also especially expensive.

[0092]The above-mentioned effect can be attained with an easy structure, and it contributes also to reduction of a manufacturing cost. There is little fear of failure and it is excellent also in endurance. Inhalation and the regurgitation can make a fluid high-speed.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention]The purpose of this invention is an easy structure and there is in providing the pump, the pumping plant, distributive-pouring head and distributive-pouring head array which can perform inhalation and the regurgitation of a fluid in high accuracy, and a distributive-pouring device.

[Translation done.]

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MEANS

[Means for Solving the Problem]Such a purpose is attained by this invention of following the (1) - (18).

[0009](1) By at least one volume variable member which comprised a substance from which volume changes by installing a fluid in housing in which an outflow / outflow which carries out ON / entrance was formed, and said housing, and impressing voltage or a magnetic field, and energization. A pump characterized for a fluid by inhalation / carrying out the regurgitation from said outflow/entrance by having an energized part which impresses voltage or a magnetic field to said volume variable member, carrying out release of energization to said energized part, or energization, and changing volume of said volume variable member.

[0010](2) A pump given in the above (1) in which said fluid is a working fluid.

[0011](3) A pump the above (1) by which said volume variable member is constituted from piezoelectric material or a magnetostrictive material, or given in (2).

[0012](4) A pump the above (1) which has said two or more volume variable members thru/or given in either of (3).

[0013](5) A pump given in the above (4) which said two or more volume variable members make tabular, respectively, leaves a crevice in the thickness direction, and is arranged in piles.

[0014](6) Said energized part is individually provided to said each volume variable member, respectively, and it is a pump the above (4) which can impress voltage or a magnetic field independently, respectively, or given in (5) to said each volume variable member.

[0015](7) A pump the above (1) for which said housing is making cylindrical shape mostly thru/or given in either of (6).

[0016](8) A pump the above (1) which is making shape with said flat housing thru/or given in either of (6).

[0017](9) A pumping plant having a pump of a statement, and a pump control means which

controls an operation of said pump in the above (1) thru/or either of (8).

[0018](10) By adjusting energizing voltage to said energized part, it is a pumping plant given in the above (9) which can adjust inhalation/discharge quantity of a fluid.

[0019](11) Said pump has said two or more volume variable members and said energized part individually provided to each volume variable member, respectively, A pumping plant of the above (9) which can adjust inhalation/discharge quantity of a fluid or a statement to (10) by what the number of said energized part which can impress voltage or a magnetic field independently to said each volume variable member, respectively, and carries out release of energization or energization is adjusted for.

[0020](12) Said pump has said two or more volume variable members and said energized part individually provided to each volume variable member, respectively, A pumping plant the above (9) which sets a time lag to each energized part, and performs release of energization or energization when voltage or a magnetic field can be independently impressed to said each volume variable member, respectively and release of energization or energization is carried out to said two or more energized parts thru/or given in either of (11).

[0021](13) By adjusting said time lag, it is a pumping plant given in the above (12) which can adjust inhalation/discharge velocity of a fluid.

[0022](14) Have a nozzle applied part which can equip with a nozzle so that it may be open for free passage at said outflow/entrance of a pump the above (1) thru/or given in either of (8), and said pump, and by the operation of said pump. A distributive-pouring head characterized for a fluid by inhalation / carrying out the regurgitation and pouring a fluid distributively from a tip opening of said nozzle.

[0023](15) A distributive-pouring head array which installs two or more distributive-pouring heads of a statement in the above (14) side by side, and is characterized by things.

[0024](16) A distributive-pouring head array given in the above (15) which said each distributive-pouring head is making flat shape, and installs said two or more distributive-pouring heads in the thickness direction side by side.

[0025](17) A distributive-pouring device equipping the above (9) thru/or either of (13) with a pumping plant of a statement at least one as a suction means.

[0026](18) A distributive-pouring device equipping the above (14) with at least one distributive-pouring head of a statement.

[0027]

[Embodiment of the Invention]Hereafter, the pump of this invention, a pumping plant, a distributive-pouring head, a distributive-pouring head array, and a distributive-pouring device are explained in detail based on the suitable embodiment shown in an accompanying drawing.

[0028]The perspective view showing the volume variable member in the distributive-pouring head which shows drawing 2 drawing of longitudinal section showing the distributive-pouring

head and nozzle in the distributive-pouring device which shows drawing 1 the perspective view in which drawing 1 shows the embodiment of the distributive-pouring device of this invention, and drawing 2, and drawing 3, and drawing 4 are the block diagrams of the distributive-pouring device shown in drawing 1.

[0029]As shown in drawing 1, the distributive-pouring device 1 is provided with the following.

Device main frame 2.

Distributive-pouring head 3.

Distributive-pouring head transportation device 4.

The distributive-pouring device 1 is provided with the pumping plant 6 of this invention as a suction means. This distributive-pouring device 1 is inhalation and a thing which carries out the regurgitation and does classification of the fluid 500, dilution, mixing, dropping work, etc. about the fluids 500, such as a drug solution and a sample, from the tip opening 302 of the nozzle 300 with which the distributive-pouring head 3 was equipped with the suction force which the pump 5 which the pumping plant 6 has generates.

[0030]The device main frame 2 has the stage 21. On the stage 21, the reagent vessel stowage 22, the reaction vessel stowage 23, and the nozzle stowage 24 are formed, respectively. In the reagent vessel stowage 22, can store two or more reagent vessels 100 which store a drug solution (charge), and to it in the reaction vessel stowage 23. Two or more reaction vessels 200 which store reaction mixture can be stored (charge), and two or more nozzles 300 for exchange can be stored in the nozzle stowage 24 (charge).

[0031]As shown in drawing 2, the distributive-pouring head 3 is provided with the following.

The pump 5 of this invention.

The nozzle applied part 31 which can equip with the nozzle 300.

Hereafter, the composition of this distributive-pouring head 3 is explained.

[0032]The pump 5 is provided with the following.

Housing 51.

Two or more volume variable members 52 installed in the housing 51.

The energized part 53 which impresses voltage to the volume variable member 52 by energization.

[0033]The housing 51 is a case which makes cylindrical shape mostly. This housing 51 comprises material with various metallic materials, ceramics, a hard resin material, etc. hard, for example, and has become a rigid body which is not expanded and contracted substantially.

[0034]The air (gas) as a working fluid flows into the pars basilaris ossis occipitalis of the housing 51, and the outflow entrance 511 which carries out ON is formed in it. The seal of the portions other than outflow entrance 511 of the housing 51 is carried out so that it may not let a

fluid pass, and airtightness (fluid-tight nature) is secured.

[0035]The volume variable member [two or more (the composition of a graphic display 14 pieces)] 52 is installed in the building envelope of the housing 51. These volume variable members 52 are the same composition mutually, and are making disc-like, respectively.

[0036]The volume variable member 52 comprises a substance from which volume changes by impressing voltage (electric field). Especially as such a substance, although not limited, piezoelectric material, such as crystal (SiO_2), lithium niobate, barium titanate, lead titanate, lead zirconate titanate (PZT), a lead metaniobate, and polyvinylidene fluoride (PVDF), is mentioned, for example.

[0037]As shown in drawing 3, to each volume variable member 52, the energized part 53 is formed individually, respectively. The energized part 53 comprises the laminated electrodes 531 and 532 and the leads (signal wire) 533 and 533 connected to the electrodes 531 and 532, respectively. The electrode 531 is contacted and formed in one field of the volume variable member 52, and the electrode 532 is contacted and formed in the field of another side of the volume variable member 52. The leads 533 and 533 are electrically connected to the pump drive circuit 12 provided outside, respectively. In drawing 2, the graphic display of the electrodes 531 and 532 and the lead 533 is omitted.

[0038]As shown in drawing 2, two or more disc-like members which consist of the volume variable member 52 and the electrodes 531 and 532 leave the crevice into which a fluid may invade, and are arranged mostly in piles at equal intervals in the thickness direction. By such arrangement, two or more volume variable members 52 can be efficiently arranged to the space in the housing 51, and it contributes to the miniaturization of the pump 5.

[0039]The supporting structure within the housing 51 of the disc-like member which consists of the volume variable member 52 and the electrodes 531 and 532 can be made into the supporting structure using the spacer which what kind of thing may be sufficient as, for example, is not illustrated. This supporting structure is the structure which can free modification which each volume variable member 52 mentions later.

[0040]As shown in drawing 4, it is connected to the control section (CPU) 11, and the pump drive circuit 12 is energized to the energized part 53 based on the control signal from the control section 11. The control section 11 controls the operation of the pump 5 like the after-mentioned based on the application program for controlling the pump 5 stored in the storage parts store 18, and the input data inputted from the input part 19. The pump control means 13 which controls the operation of the pump 5 comprises the control section 11, the pump drive circuit 12, the storage parts store 18, and the input part 19.

[0041]If it energizes to the energized part 53, the voltage (electric field) produced between the electrode 531 and the electrode 532 will be impressed to the volume variable member 52. According to the piezo-electric effect, it will elongate to the thickness direction and the volume

variable member 52 will be contracted to a diametral direction, if voltage is impressed. And if impression of voltage is canceled, the volume variable member 52 will return to the original shape.

[0042]When the volume of the volume variable member 52 before and after such modification is measured, the volume of the volume variable member 52 in the state where voltage was impressed is slightly larger than the volume in the state where voltage is not impressed. That is, if the volume variable member 52 impresses voltage, volume will increase, and if impression of voltage is canceled, volume will decrease.

[0043]Since the capacity of the left-behind space (space which is not occupied by volume variable member 52 grade) in the housing 51 will decrease if the volume of the volume variable member 52 increases, the air in the housing 51 flows out and it flows out from the entrance 511. On the contrary, since the capacity of the left-behind space in the housing 51 will increase if the volume of the volume variable member 52 decreases, air flows out and it flows in the housing 51 from the entrance 511. Thus, as for the pump 5, inhalation and the regurgitation carry out air from the outflow entrance 511.

[0044]The pumping plant 6 of this invention comprises such a pump 5 and the pump control means 13 (refer to drawing 4).

[0045]As shown in drawing 2, the nozzle applied part 31 is formed in the pump 5 bottom. The channel 311 which is open for free passage at the outflow entrance 511 is formed in the inside of the nozzle applied part 31. If the nozzle applied part 31 is equipped with the nozzle 300, the lumen of the nozzle 300 will flow out via the channel 311, and will be open for free passage at the entrance 511 (inside of the housing 51).

[0046]The portion by the side of the lower end of the nozzle applied part 31 is the tapered shape which an outer diameter dwindles toward down. When this tapered shape portion inserts without a crevice and fits in in the end face opening 301 of the nozzle 300, the nozzle 300 is fixed in airtight to the nozzle applied part 31, enabling free attachment and detachment. the nozzle 300 comprises various resin materials etc. preferably, for example -- being disposable (throwing away) -- it has become.

[0047]When pouring a different fluid distributively, contamination can be prevented by exchanging the nozzle 300. As for exchange of the nozzle 300, it is preferred that the nozzle replacement mechanism in which make it move to the nozzle stowage 24, and the distributive-pouring head 3 is not illustrated can perform now automatically.

[0048]It may be what it may be equipped with the nozzle 300 by screwing in this invention not only to composition like a graphic display but to the nozzle applied part 31, enabling free attachment and detachment, and the nozzle 300 cannot detach and attach to the distributive-pouring head 3.

[0049]As shown in drawing 1, the distributive-pouring head transportation device 4 is provided

with the following.

The rising and falling mechanism 41 which supports the distributive-pouring head 3 which was explained above movable in the perpendicular direction (Z shaft orientations).

Y axial movement mechanism 42 which moves the rising and falling mechanism 41 horizontally (Y shaft orientations).

X axial movement mechanism 43 which moves Y axial movement mechanism 42 to a horizontal direction (X axial direction) vertical to a Y-axis.

By such composition, the distributive-pouring head transportation device 4 can move the distributive-pouring head 3 now in the direction of a three dimension on the stage 21.

[0050]The operation of the distributive-pouring head transportation device 4 is controlled by the control section 11 based on the application program for controlling the distributive-pouring head transportation device 4 stored in the storage parts store 18, and the input data inputted from the input part 19.

[0051]The rising and falling mechanism 41, Y axial movement mechanism 42, and X axial movement mechanism 43 can be used as the arbitrary mechanisms which the mechanism of what kind of structure may be sufficient as, for example, used a feed screw, a rack & pinion gear, a servo motor, a fluid pressure cylinder, etc.

[0052]Such a distributive-pouring device 1 does the distributive-pouring work of classification of the fluid 500, dilution, mixing, dropping, etc., moving the distributive-pouring head 3 between each reagent vessel 100 and each reaction vessel 200 by the operation of the distributive-pouring head transportation device 4.

[0053]Hereafter, the case where the fluid 500 in the reagent vessel 100 is classified for the operation of the distributive-pouring device 1 to the reaction vessel 200 is explained to an example.

[0054][1] The tip opening 302 of the nozzle 300 energizes on predetermined voltage to all the energized parts 53 by the state of being in the air, first. All the volume variable members 52 will be increased by volume by this.

[0055][2] Rank second, operate the distributive-pouring head transportation device 4, and move the distributive-pouring head 3 so that the tip opening 302 of the nozzle 300 may be located below the oil level of the fluid 500 in the reagent vessel 100.

[0056][3] In this state, if the energization to the energized part 53 is canceled, when the volume of the volume variable member 52 decreases, the air in the nozzle 300 will flow out, it will be inhaled in the housing 51 from the entrance 511, and the pressure in the nozzle 300 will decline. The fluid 500 is inhaled in the nozzle 300 from the tip opening 302 by this failure of pressure (refer to drawing 2).

[0057]At this time, the quantity of the fluid 500 inhaled in the nozzle 300 can be adjusted by adjusting the number of the energized part 53 which cancels energization. That is, when the

number of the energized part 53 which cancels energization is one piece, the fluid 500 of the quantity corresponding to the amount of volume decreases of the one volume variable member 52 is inhaled in the nozzle 300. And the suction quantity of the fluid 500 will be the 2 and 3, ..., 14 times in general to the time of canceling energization of the one energized part 53 by considering it as two pieces, three pieces, ..., the 14 number of the energized part 53 which cancels energization. Thus, the suction quantity of the fluid 500 can be adjusted to 14 steps. [0058]When it is a thing of the character in which volume does not return to the original size (size of a standard) thoroughly at this time even if the volume variable member 52 makes impressed electromotive force zero, That is, when it is what has a hysteresis in the volume change of the volume variable member 52, after canceling the energization to the energized part 53, it is good also as performing control which impresses the voltage of an opposite direction to the energized part 53 so that the volume of the volume variable member 52 may return to the size of a standard. The fixed reference voltage in the energized part 53 is impressed in front of the above [1], Voltage higher than this can be impressed to the energized part 53 by [1], control of returning the impressed electromotive force to the energized part 53 to said reference voltage by [3] may be carried out, and influence of a hysteresis can be made small by this control. Higher-precision distributive pouring can be performed by performing these control [like]. In this specification, as mentioned above, after canceling the energization to the energized part 53, it is only called "release of energization" also including the case where the voltage of an opposite direction is impressed, and the case where the impressed electromotive force to the energized part 53 is returned to a certain fixed reference voltage. [0059]In inhalation operation of such a fluid 500, if the energization to those energized parts 53 is simultaneously canceled when canceling the energization to two or more energized parts 53, the fluid 500 can be inhaled at high speed. [0060]When canceling the energization to two or more energized parts 53, a time lag may be set to each energized part 53, and energization may be canceled. In this case, the suction speed of the fluid 500 can be adjusted by adjusting that time lag. That is, if the time lag is lengthened, suction speed can be made late, and suction speed can be made quick if the time lag is shortened. [0061][4] If the fluid 500 is inhaled in the nozzle 300, the distributive-pouring head transportation device 4 will be operated, and the distributive-pouring head 3 will be moved to the position of the reaction vessel 200. [0062][5] Rank second and energize on predetermined voltage again to the energized part 53 which canceled energization. The volume of the energized volume variable member 52 increases by this, the air in the housing 51 flows out, it flows out of the entrance 511, and the pressure in the nozzle 300 increases. The regurgitation (discharge) of the fluid 500 in the nozzle 300 is carried out from the tip opening 302 by this pressure increase. By making this

breathed-out fluid 500 dropped at the reaction vessel 200 (fall), it gives into the reaction vessel 200. When adhered to the tip opening 302 neighborhood by the breathed-out fluid 500, It is better also as giving the breathed-out fluid 500 into the reaction vessel 200 than operate the distributive-pouring head transportation device 4 and contacting the tip part of the nozzle 300 into the wall of the reaction vessel 200, or the fluid in it.

[0063]In the case of such discharging of the fluid 500, the quantity of the fluid 500 which carries out the regurgitation can be adjusted by adjusting the number of the energized part 53 to energize like the time of the aforementioned inhalation operation.

[0064]If it energizes simultaneously to those energized parts 53 when energizing to two or more energized parts 53 in discharging of such a fluid 500, the regurgitation of the fluid 500 can be carried out at high speed. Depending on conditions, such as discharge quantity and an opening diameter of the tip opening 302, from the nozzle 300, as the fluid 500 is injected, the regurgitation can also be carried out.

[0065]When energizing to two or more energized parts 53 in discharging of the fluid 500, a time lag may be set and energized to each energized part 53. In this case, the discharge velocity of the fluid 500 can be adjusted by adjusting that time lag. That is, if the time lag is lengthened, discharge velocity can be made late, and discharge velocity can be made quick if the time lag is shortened.

[0066][6] By moving the distributive-pouring head 3 to other reaction vessels 200, and repeating operation of [5], the fluid 500 in the reagent vessel 100 is classifiable to each reaction vessel 200.

[0067]Thus, by the volume change of the volume variable member 52, in a fluid, the regurgitation is carried out and the pump 5 of this invention does not have [inhalation and] a mechanical flexible region. Therefore, since adverse effects, such as mechanical backlash and a backlash, are not received, suction quantity and discharge quantity are controllable by high accuracy (adjustment). In particular, in high accuracy, it can inhale and the regurgitation also of very little fluids can be carried out. Structure is easy and contributes also to reduction of a manufacturing cost. Since there is no flexible region, there is little fear of failure and it is excellent also in endurance.

[0068]In the distributive-pouring head 3 and the distributive-pouring device 1 of this invention provided with such a pump 5 (pumping plant 6), the amount of distributive pouring can be controlled by high accuracy (adjustment), and very little fluids can also be especially poured distributively in high accuracy.

[0069]In this embodiment, the energized part 53 is individually formed to two or more volume variable members 52, respectively, and when impression has become possible about voltage independently to each volume variable member 52, respectively, suction quantity and discharge quantity can be adjusted easily and with high precision. In this invention, when

forming two or more volume variable members 52, the number in particular is not limited, for example, can be made into about 2-1000 pieces. By increasing the number of the volume variable member 52, suction quantity and discharge quantity can be adjusted more broadly from a minute amount to comparatively large quantity, and with high precision.

[0070]The setting number of the volume variable member 52 seems to have become settled in the value predetermined in suction quantity and discharge quantity in this invention at one piece. Even when the number of the volume variable members 52 is one, by adjusting the energizing voltage to the energized part 53, the amount of volume changes of the volume variable member 52 can be adjusted, and, thereby, suction quantity and discharge quantity can also be adjusted.

[0071]Also when two or more volume variable members 52 are installed, it may be made to adjust the energizing voltage to the energized part 53. Thereby, suction quantity and discharge quantity can be adjusted with the more sufficient accuracy on a multi stage story.

[0072]Volume seems to decrease by impression of voltage in this invention to the embodiment and reverse which the volume variable member 52 mentioned above.

[0073]Although the target fluid 500 was poured distributively inhalation and by carrying out the regurgitation by using air (gas) as a working fluid in this embodiment, an insulating fluid may be sufficient as a working fluid in this invention. That is, it fills up with an insulating liquid in the housing 51, and the fluid 500 may be poured distributively via inhalation and the insulating liquid which carries out the regurgitation from the outflow entrance 511. When an insulating tunic is formed in the volume variable member 52 and the surface of the energized part 53, a fluid without insulation may be sufficient as a working fluid.

[0074]A volume variable member may be constituted from this invention by impression of a magnetic field by the substance from which volume changes (magnetostrictive effects). Especially as such a substance, although not limited, various magnetostrictive materials, such as a Tb-Dy-Fe alloy, a super magnetostriction material, etc. are mentioned, for example. In this case, as an energized part, the coil which impresses a magnetic field to this volume variable member by energization can be used, for example.

[0075]Drawing 5 is a perspective view showing the embodiment of the distributive-pouring head array of this invention. Hereafter, although the embodiment of the distributive-pouring head array of this invention is described with reference to this figure, it explains focusing on a point of difference with the embodiment mentioned above, and the same matter omits that explanation.

[0076]The distributive-pouring head array 7 shown in drawing 5 installs the distributive-pouring head [two or more (the composition of a graphic display 16 pieces)] 71 side by side. The distributive-pouring head 71 is the same as said distributive-pouring head 3 except the shape differing.

[0077]The housing 711 of the pump in the distributive-pouring head 71 is making flat rectangular parallelepiped shape. In the housing 711, the tabular volume variable member with long and slender plurality (large number) is arranged in piles.

[0078]The distributive-pouring head array 7 installs two or more such thin distributive-pouring heads 71 in the thickness direction side by side at a single tier. Since the mechanical driving source is an easy unnecessary structure, the pump of this invention has the high flexibility of shape. Therefore, such a thin distributive-pouring head 71 and the small distributive-pouring head array 7 of an array pitch are easily realizable.

[0079]When pouring distributively to the microplate (multi-hole plate) which can be poured distributively at once to two or more places for example, by which many holes were formed in matrix form according to the distributive-pouring device provided with such a distributive-pouring head array 7, it can pour distributively promptly at very high efficiency.

[0080]Drawing 6 is drawing of longitudinal section showing other embodiments of the pump of this invention. Hereafter, although other embodiments of the pump of this invention are described with reference to this figure, it explains focusing on a point of difference with the embodiment mentioned above, and the same matter omits that explanation.

[0081]Pump 5' of this embodiment sends out a fluid toward right-hand side from the left-hand side in drawing 6. This pump 5' is applicable to other devices of various kinds of which send out not only a distributive-pouring device but a fluid.

[0082]Pump 5' is provided with the following.

It has the almost same composition as said pump 5, and is housing 51'.

Two or more volume variable members 52 installed in housing 51'.

The energized part 53 which impresses voltage to the volume variable member 52 by energization.

[0083]The input 512 where a fluid flows, and the tap hole 513 where a fluid flows out are established in housing 51', respectively. That is, in this embodiment, the input 512 and the tap hole 513 are separately formed in housing 51'. In the middle of the channel 14 connected to the input 512, the check valve (check valve) 16 is formed and the check valve (check valve) 17 is formed in the middle of the channel 15 connected to the tap hole 513.

[0084]If pump 5' operates like the above, pump 5' will inhale a fluid from the input 512, and will carry out the regurgitation of the fluid from the tap hole 513. Thereby, the fluid in the channel 14 and 15 can be sent out rightward in drawing 6.

[0085]That is, although said pumps 5 were inhalation and a thing which carries out the regurgitation about the target fluid 500 via the air (gas) which is a working fluid, directly, it inhales and breathes out and pump 5' of this embodiment sends out the target fluid.

[0086]As a fluid which pump 5' sends out, a fluid or a gas may be sufficient. In the case of a

fluid, it is preferred that the insulating tunic is formed in the volume variable member 52 and the surface of the energized part 53.

[0087]Although there may not be the check valves 16 and 17, it is preferred that at least one side of the check valves 16 and 17 is provided.

[0088]As mentioned above, although the embodiment of the graphic display of the pump, the pumping plant, the distributive-pouring head, distributive-pouring head array, and distributive-pouring device of this invention was described, This invention is not limited to this and each part which constitutes a pump, a pumping plant, a distributive-pouring head, a distributive-pouring head array, and a distributive-pouring device can be replaced by the thing of arbitrary composition of that the same function can be exhibited. Arbitrary structures may be added.

[0089]Although this invention is applicable from what has 1 time of comparatively large inhalation / discharge quantity to a very small quantity thing, 1 time of inhalation/discharge quantity are suitable for it to the minute amount thing which is about 1 nano liter -100 microliter especially.

[0090]The thing of what kind of shape, such as not only a tabular thing but rod form, block like shape, etc., may be sufficient as a volume variable member. What kind of thing may be sufficient also as the modification mode of a volume variable member when voltage or a magnetic field is impressed.

[Translation done.]

* NOTICES *

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1]It is a perspective view showing the embodiment of the distributive-pouring device of this invention.

[Drawing 2]It is drawing of longitudinal section showing the distributive-pouring head and nozzle in the distributive-pouring device shown in drawing 1.

[Drawing 3]It is a perspective view showing the volume variable member in the distributive-pouring head shown in drawing 2.

[Drawing 4]It is a block diagram of the distributive-pouring device shown in drawing 1.

[Drawing 5]It is a perspective view showing the embodiment of the distributive-pouring head array of this invention.

[Drawing 6]It is drawing of longitudinal section showing other embodiments of the pump of this invention.

[Description of Notations]

- 1 Distributive-pouring device
- 2 Device main frame
- 21 Stage
- 22 Reagent vessel stowage
- 23 Reaction vessel stowage
- 24 Nozzle stowage
- 3 Distributive-pouring head
- 31 Nozzle applied part
- 311 Channel
- 4 Distributive-pouring head transportation device
- 41 Rising and falling mechanism
- 42 Y axial movement mechanism

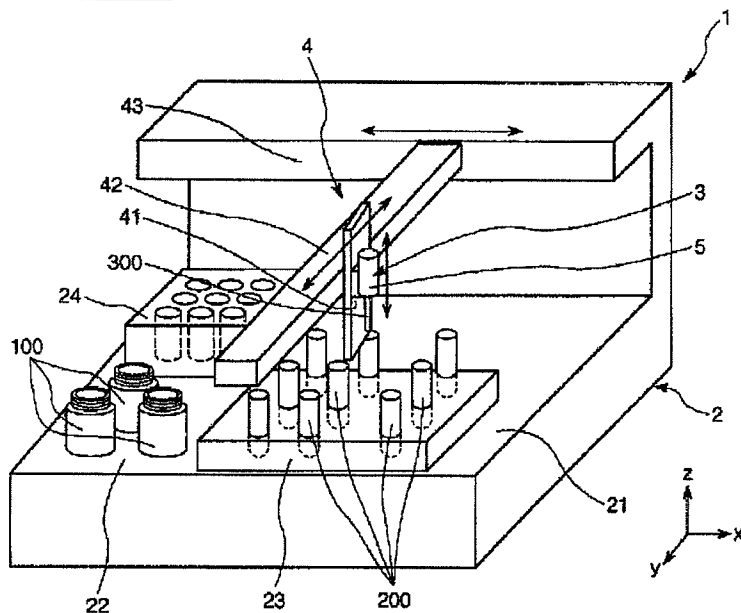
43 X axial movement mechanism
5 and 5' pump
51 and 51' housing
511 Outflow entrance
512 Input
513 Tap hole
52 Volume variable member
53 Energized part
531 and 532 Electrode
533 Lead
6 Pumping plant
7 Distributive-pouring head array
71 Distributive-pouring head
711 Housing
11 Control section
12 Pump drive circuit
13 Pump control means
14 and 15 Channel
16 and 17 Check valve
18 Storage parts store
19 Input part
100 Reagent vessel
200 Reaction vessel
300 Nozzle
301 End face opening
302 Tip opening
500 Fluid

[Translation done.]

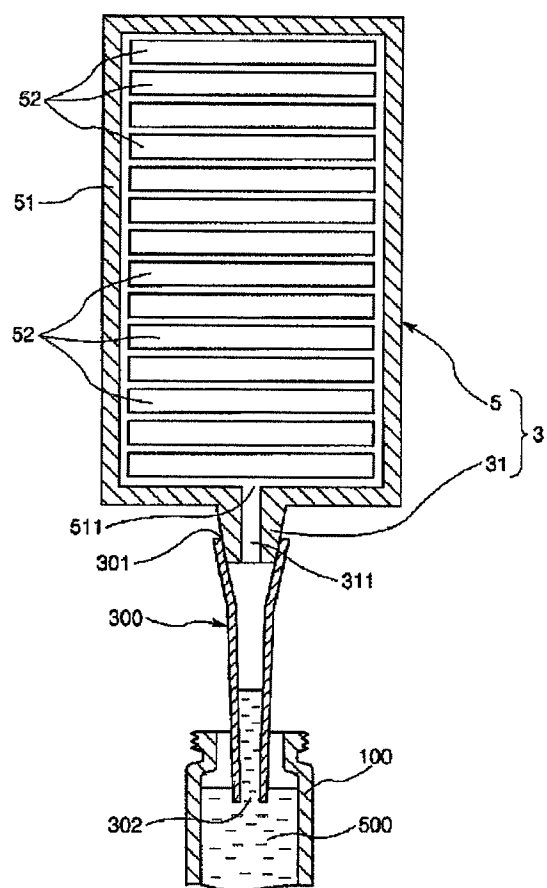
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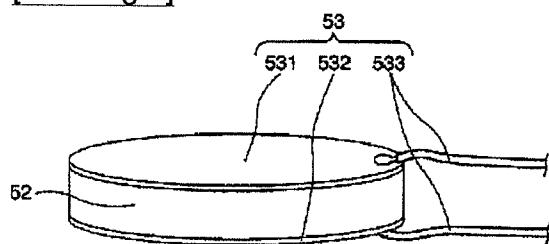
[Drawing 1]



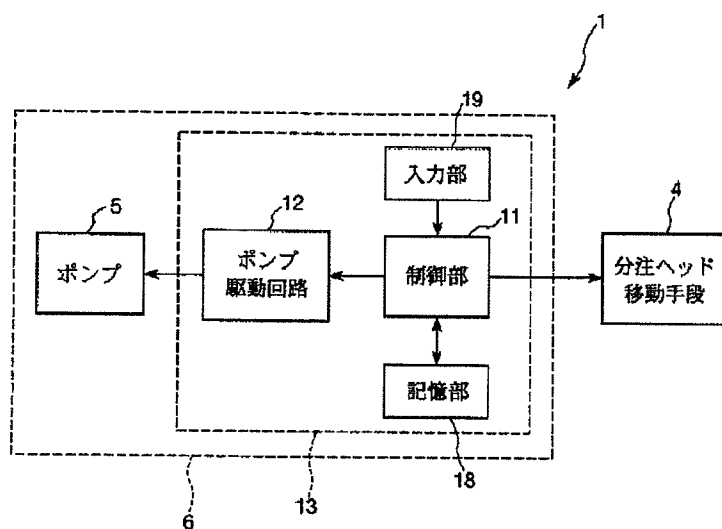
[Drawing 2]



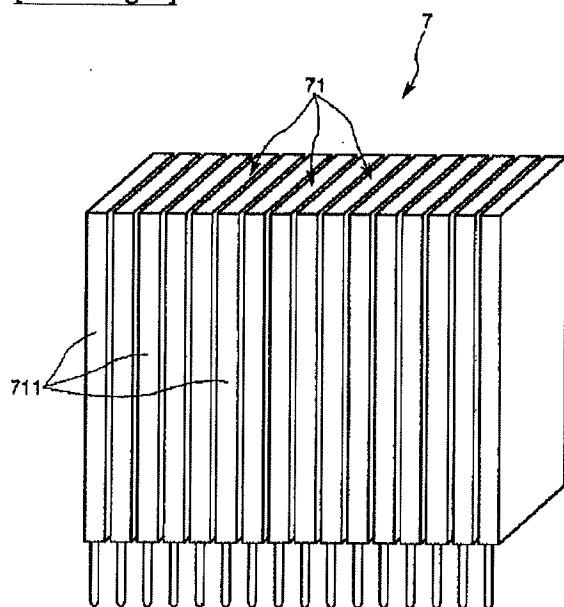
[Drawing 3]



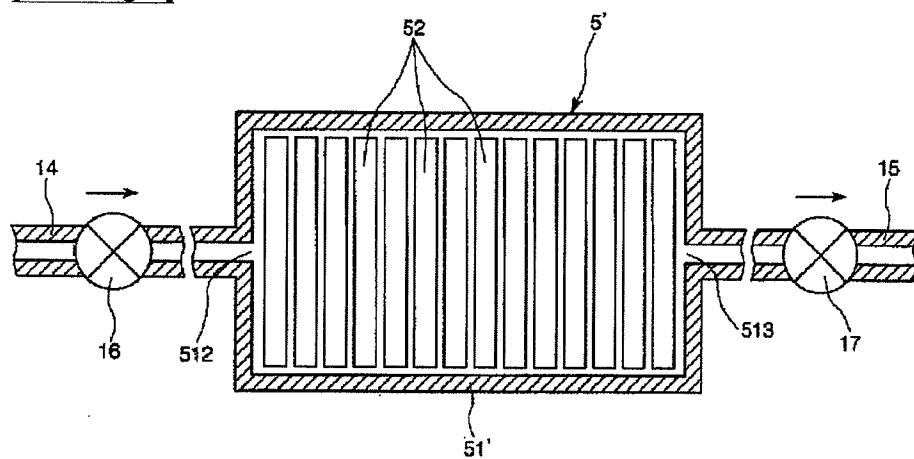
[Drawing 4]



[Drawing 5]

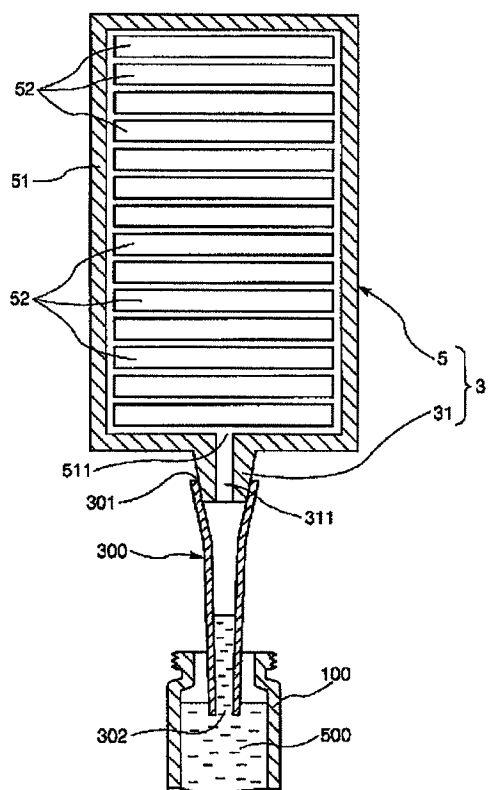


[Drawing 6]



[Translation done.]

Drawing selection Representative drawing



[Translation done.]

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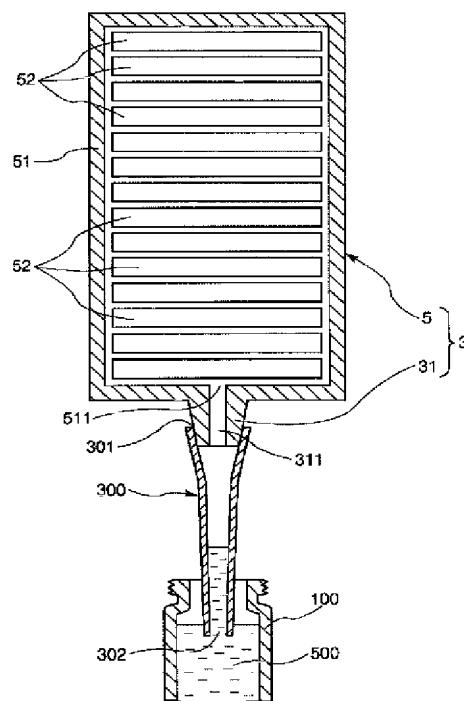
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(54) 【発明の名称】 ポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置

(57) 【要約】

【課題】簡単な構造で、高い精度で流体の吸入・吐出を行うことができるポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置を提供すること。

【解決手段】分注ヘッド3は、ポンプ5と、ノズル300を装着可能なノズル装着部31とを有している。ポンプ5は、ハウジング51と、ハウジング51内に設置された複数の体積可変部材52と、通電により体積可変部材52に電圧を印加する通電部（電極）とを有している。体積可変部材52に電圧を印加すると、その体積が増大し、ハウジング51内の残された空間の容積が減少して、ハウジング51内の空気が流出入口511より流出し、ノズル300内の液体500が吐出される。体積可変部材52への電圧の印加を解除すると、体積可変部材52の体積が減少し、ノズル300内の空気が流出入口511よりハウジング51内に流入し、ノズル300内に液体500が吸入される。



【特許請求の範囲】

【請求項1】 流体が流出／入する流出／入口が形成されたハウジングと、

前記ハウジング内に設置され、電圧または磁場を印加することにより体積が変化する物質で構成された少なくとも1つの体積可変部材と、

通電により、前記体積可変部材に電圧または磁場を印加する通電部とを有し、

前記通電部に対する通電または通電の解除をして、前記体積可変部材の体積を変化させることにより、前記流出／入口から流体を吸入／吐出することを特徴とするポンプ。

【請求項2】 前記流体は、作動流体である請求項1に記載のポンプ。

【請求項3】 前記体積可変部材は、圧電材料または磁歪材料で構成されている請求項1または2に記載のポンプ。

【請求項4】 複数個の前記体積可変部材を有する請求項1ないし3のいずれかに記載のポンプ。

【請求項5】 複数個の前記体積可変部材は、それぞれ板状をなし、その厚さ方向に隙間を空けて重ねて配置されている請求項4に記載のポンプ。

【請求項6】 前記各体積可変部材に対しそれぞれ個別に前記通電部が設けられており、前記各体積可変部材に対しそれぞれ独立して電圧または磁場を印加可能である請求項4または5に記載のポンプ。

【請求項7】 前記ハウジングは、ほぼ円筒状をなしている請求項1ないし6のいずれかに記載のポンプ。

【請求項8】 前記ハウジングは、扁平な形状をなしている請求項1ないし6のいずれかに記載のポンプ。

【請求項9】 請求項1ないし8のいずれかに記載のポンプと、前記ポンプの作動を制御するポンプ制御手段とを有することを特徴とするポンプ装置。

【請求項10】 前記通電部への通電電圧を調整することにより、流体の吸入／吐出量を調整可能である請求項9に記載のポンプ装置。

【請求項11】 前記ポンプは、複数個の前記体積可変部材と、各体積可変部材に対しそれぞれ個別に設けられた前記通電部とを有し、前記各体積可変部材に対しそれぞれ独立に電圧または磁場を印加可能であり、通電または通電の解除をする前記通電部の個数を調整することにより、流体の吸入／吐出量を調整可能である請求項9または10に記載のポンプ装置。

【請求項12】 前記ポンプは、複数個の前記体積可変部材と、各体積可変部材に対しそれぞれ個別に設けられた前記通電部とを有し、前記各体積可変部材に対しそれぞれ独立に電圧または磁場を印加可能であり、複数個の前記通電部に通電または通電の解除をする際、各通電部に対し時間差を置いて通電または通電の解除を行う請求項9ないし11のいずれかに記載のポンプ装

置。

【請求項13】 前記時間差を調整することにより、流体の吸入／吐出速度を調整可能である請求項12に記載のポンプ装置。

【請求項14】 請求項1ないし8のいずれかに記載のポンプと、前記ポンプの前記流出／入口に連通するようにノズルを装着可能なノズル装着部とを有し、前記ポンプの作動により、前記ノズルの先端開口から液体を吸入／吐出して、液体を分注することを特徴とする分注ヘッド。

【請求項15】 請求項14に記載の分注ヘッドを複数並設してなることを特徴とする分注ヘッドアレイ。

【請求項16】 前記各分注ヘッドは、扁平な形状をなしており、複数個の前記分注ヘッドをその厚さ方向に並設してなる請求項15に記載の分注ヘッドアレイ。

【請求項17】 請求項9ないし13のいずれかに記載のポンプ装置を吸引手段として少なくとも1つ備えることを特徴とする分注装置。

【請求項18】 請求項14に記載の分注ヘッドを少なくとも1つ備えることを特徴とする分注装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】本発明は、ポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置に関する。

【0002】

【従来の技術】例えば検体、試薬等の少量の液体の仕分け、希釈、混合、滴下作業などを行う分注装置が知られている。この分注装置は、例えば臨床検査の分野や基礎研究の分野などにおいて使用されている。

【0003】従来の分注装置における分注ヘッドは、筒状体とこの筒状体内で摺動するピストンとを有するシリンジと、ピストンを移動させるピストン移動機構と、シリンジ内に連通するノズルとを備えている。そして、ピストン移動機構によってピストンを移動させ、シリンジ内の圧力を変化させることにより、ノズルの先端開口から液体を吸入・吐出する。

【0004】しかしながら、従来の分注ヘッドでは、例えば送りねじなどを用いた機械的なピストン移動機構を必要とするため、構造が複雑であり、製造コストが高いという問題があった。

【0005】また、ピストン移動機構の機械的ガタ、バックラッシュなどにより、ピストンの位置制御の精度向上が困難であるため、分注量の精度を向上するのが困難であった。特に、微量の液体を高い精度で分注することができなかった。

【0006】また、ピストン移動機構は、機械的な動作を行うものであるため、比較的故障を起こしやすく、耐久性にも劣っていた。

【0007】

【発明が解決しようとする課題】本発明の目的は、簡単な構造で、高精度で流体の吸入・吐出を行うことができるポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置を提供することにある。

【0008】

【課題を解決するための手段】このような目的は、下記(1)～(18)の本発明により達成される。

【0009】(1) 流体が流出／入する流出／入口が形成されたハウジングと、前記ハウジング内に設置され、電圧または磁場を印加することにより体積が変化する物質で構成された少なくとも1つの体積可変部材と、通電により、前記体積可変部材に電圧または磁場を印加する通電部とを有し、前記通電部に対する通電または通電の解除をして、前記体積可変部材の体積を変化させることにより、前記流出／入口から流体を吸入／吐出することを特徴とするポンプ。

【0010】(2) 前記流体は、作動流体である上記(1)に記載のポンプ。

【0011】(3) 前記体積可変部材は、圧電材料または磁歪材料で構成されている上記(1)または(2)に記載のポンプ。

【0012】(4) 複数の前記体積可変部材を有する上記(1)ないし(3)のいずれかに記載のポンプ。

【0013】(5) 複数の前記体積可変部材は、それぞれ板状をなし、その厚さ方向に隙間を空けて重ねて配置されている上記(4)に記載のポンプ。

【0014】(6) 前記各体積可変部材に対しそれぞれ個別に前記通電部が設けられており、前記各体積可変部材に対しそれぞれ独立して電圧または磁場を印加可能である上記(4)または(5)に記載のポンプ。

【0015】(7) 前記ハウジングは、ほぼ円筒状をなしている上記(1)ないし(6)のいずれかに記載のポンプ。

【0016】(8) 前記ハウジングは、扁平な形状をなしている上記(1)ないし(6)のいずれかに記載のポンプ。

【0017】(9) 上記(1)ないし(8)のいずれかに記載のポンプと、前記ポンプの作動を制御するポンプ制御手段とを有することを特徴とするポンプ装置。

【0018】(10) 前記通電部への通電電圧を調整することにより、流体の吸入／吐出量を調整可能である上記(9)に記載のポンプ装置。

【0019】(11) 前記ポンプは、複数の前記体積可変部材と、各体積可変部材に対しそれぞれ個別に設けられた前記通電部とを有し、前記各体積可変部材に対しそれぞれ独立に電圧または磁場を印加可能であり、通電または通電の解除をする前記通電部の個数を調整することにより、流体の吸入／吐出量を調整可能である上記(9)または(10)に記載のポンプ装置。

【0020】(12) 前記ポンプは、複数の前記体

積可変部材と、各体積可変部材に対しそれぞれ個別に設けられた前記通電部とを有し、前記各体積可変部材に対しそれぞれ独立に電圧または磁場を印加可能であり、複数の前記通電部に通電または通電の解除をする際、各通電部に対し時間差をおいて通電または通電の解除を行う上記(9)ないし(11)のいずれかに記載のポンプ装置。

【0021】(13) 前記時間差を調整することにより、流体の吸入／吐出速度を調整可能である上記(12)に記載のポンプ装置。

【0022】(14) 上記(1)ないし(8)のいずれかに記載のポンプと、前記ポンプの前記流出／入口に連通するようにノズルを装着可能なノズル装着部とを有し、前記ポンプの作動により、前記ノズルの先端開口から液体を吸入／吐出して、液体を分注することを特徴とする分注ヘッド。

【0023】(15) 上記(14)に記載の分注ヘッドを複数並設してなることを特徴とする分注ヘッドアレイ。

【0024】(16) 前記各分注ヘッドは、扁平な形状をなしており、複数の前記分注ヘッドをその厚さ方向に並設してなる上記(15)に記載の分注ヘッドアレイ。

【0025】(17) 上記(9)ないし(13)のいずれかに記載のポンプ装置を吸引手段として少なくとも1つ備えることを特徴とする分注装置。

【0026】(18) 上記(14)に記載の分注ヘッドを少なくとも1つ備えることを特徴とする分注装置。

【0027】

【発明の実施の形態】以下、本発明のポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置を添付図面に示す好適な実施形態に基づいて詳細に説明する。

【0028】図1は、本発明の分注装置の実施形態を示す斜視図、図2は、図1に示す分注装置における分注ヘッドおよびノズルを示す縦断面図、図3は、図2に示す分注ヘッドにおける体積可変部材を示す斜視図、図4は、図1に示す分注装置のブロック図である。

【0029】図1に示すように、分注装置1は、装置本体2と、分注ヘッド3と、分注ヘッド移動手段4とを有している。また、分注装置1は、本発明のポンプ装置6を吸引手段として備えている。この分注装置1は、ポンプ装置6が有するポンプ5が発生する吸引力により、分注ヘッド3に装着されたノズル300の先端開口302から薬液、検体等の液体500を吸入・吐出して、液体500の仕分け、希釈、混合、滴下作業などを行うものである。

【0030】装置本体2は、ステージ21を有している。ステージ21上には、試薬容器収納部22と、反応容器収納部23と、ノズル収納部24とがそれぞれ設け

られている。試薬容器収納部22には、薬液を貯留する試薬容器100を複数個収納(装填)することができ、反応容器収納部23には、反応液を貯留する反応容器200を複数個収納(装填)することができ、ノズル収納部24には、交換用のノズル300を複数個収納(装填)することができる。

【0031】図2に示すように、分注ヘッド3は、本発明のポンプ5と、ノズル300を装着可能なノズル装着部31とを有している。以下、この分注ヘッド3の構成について説明する。

【0032】ポンプ5は、ハウジング51と、ハウジング51内に設置された複数の体積可変部材52と、通電により体積可変部材52に電圧を印加する通電部53とを有している。

【0033】ハウジング51は、ほぼ円筒状をなす筐体である。このハウジング51は、例えば各種金属材料、セラミック、硬質樹脂材料などの硬質な材料で構成され、実質的に伸縮しない剛体になっている。

【0034】ハウジング51の底部には、作動流体としての空気(気体)が流出入する流出入口511が形成されている。ハウジング51の流出入口511以外の部分は、流体を通さないようにシールされ、気密性(液密性)が確保されている。

【0035】ハウジング51の内部空間には、複数個(図示の構成では、14個)の体積可変部材52が設置されている。これらの体積可変部材52は、互いに同様の構成であり、それぞれ円板状をなしている。

【0036】体積可変部材52は、電圧(電場)を印加することにより体積が変化する物質で構成されている。このような物質としては、特に限定されないが、例えば、水晶(SiO_2)、ニオブ酸リチウム、チタン酸バリウム、チタン酸鉛、チタン酸ジルコン酸鉛(PZT)、メタニオブ酸鉛、ポリフッ化ビニリデン(PVDF)等の圧電材料が挙げられる。

【0037】図3に示すように、各体積可変部材52に対しては、それぞれ個別に通電部53が設けられている。通電部53は、薄板状の電極531および532と、電極531および532にそれぞれ接続されたリード線(信号線)533、533とで構成されている。電極531は、体積可変部材52の一方の面に接触して設けられており、電極532は、体積可変部材52の他方の面に接触して設けられている。リード線533、533は、それぞれ、外部に設けられたポンプ駆動回路12に対し電気的に接続されている。なお、図2中では、電極531、532およびリード線533の図示を省略する。

【0038】図2に示すように、体積可変部材52と電極531、532とからなる複数の円板状部材は、流体が侵入し得る隙間を空けてその厚さ方向にほぼ等間隔で重ねて配置されている。このような配置により、複数個

の体積可変部材52をハウジング51内のスペースに効率よく配置することができ、ポンプ5の小型化に寄与する。

【0039】なお、体積可変部材52と電極531、532とからなる円板状部材のハウジング51内での支持構造は、いかなるものでもよく、例えば図示しないスペーサを用いた支持構造とすることができる。また、この支持構造は、各体積可変部材52が後述するような変形を自由に行うことができるような構造になっている。

【0040】図4に示すように、ポンプ駆動回路12は、制御部(CPU)11に接続されており、制御部11からの制御信号に基づいて、通電部53に対し通電するものである。制御部11は、記憶部18に格納されたポンプ5を制御するためのアプリケーションプログラムや、入力部19から入力された入力データに基づいて、ポンプ5の作動を後述のように制御する。なお、制御部11と、ポンプ駆動回路12と、記憶部18と、入力部19とで、ポンプ5の作動を制御するポンプ制御手段13が構成される。

【0041】通電部53に通電されると、電極531と電極532との間に生じる電圧(電場)が体積可変部材52に印加される。体積可変部材52は、電圧が印加されると、圧電効果により、その厚さ方向に伸張し、直径方向に収縮する。そして、電圧の印加を解除すると、体積可変部材52は、元の形状に戻る。

【0042】このような変形の前後における体積可変部材52の体積を比較すると、電圧を印加した状態での体積可変部材52の体積は、電圧を印加していない状態での体積より、僅かに大きい。すなわち、体積可変部材52は、電圧を印加すると体積が増大し、電圧の印加を解除すると、体積が減少する。

【0043】体積可変部材52の体積が増大すると、ハウジング51内の残された空間(体積可変部材52等に占有されていない空間)の容積が減少するため、ハウジング51内の空気が流出入口511より流出する。逆に、体積可変部材52の体積が減少すると、ハウジング51内の残された空間の容積が増大するため、空気が流出入口511よりハウジング51内に流入する。このようにして、ポンプ5は、流出入口511より空気を吸入・吐出する。

【0044】なお、本発明のポンプ装置6は、このようなポンプ5と、ポンプ制御手段13とで構成される(図4参照)。

【0045】図2に示すように、ポンプ5の下側には、ノズル装着部31が形成されている。ノズル装着部31の内部には、流出入口511に連通する流路311が形成されている。ノズル装着部31にノズル300を装着すると、ノズル300の内腔は、流路311を介して流出入口511(ハウジング51の内部)に連通する。

【0046】ノズル装着部31の下端側の部分は、下方

向に向かって外径が漸減するテーパ状になっている。このテーパ状の部分がノズル300の基端開口301内に隙間なく挿入し嵌合することにより、ノズル300がノズル装着部31に対し着脱自在に気密的に固定される。ノズル300は、好ましくは、例えば各種樹脂材料等で構成されており、ディスポーザブル（使い捨て）となっている。

【0047】異なる液体を分注する際には、ノズル300を交換することによりコンタミネーションを防止することができる。ノズル300の交換は、分注ヘッド3をノズル収納部24に移動させ、図示しないノズル交換機構により自動的に行うことができるようになっているのが好ましい。

【0048】なお、本発明では、図示のような構成に限らず、ノズル装着部31に対しノズル300が例えば螺合により着脱自在に装着されるものであってもよく、ノズル300が分注ヘッド3に対し着脱できないようなものであってもよい。

【0049】図1に示すように、分注ヘッド移動手段4は、以上説明したような分注ヘッド3を鉛直方向（Z軸方向）に移動可能に支持する昇降機構41と、昇降機構41を水平方向（Y軸方向）に移動するY軸方向移動機構42と、Y軸方向移動機構42をY軸に垂直な水平方向（X軸方向）に移動するX軸方向移動機構43とを有している。このような構成により、分注ヘッド移動手段4は、分注ヘッド3をステージ21上で3次元方向に移動させることができるようになっている。

【0050】分注ヘッド移動手段4の作動は、記憶部18に格納された分注ヘッド移動手段4を制御するためのアプリケーションプログラムや、入力部19から入力された入力データに基づいて、制御部11により制御される。

【0051】なお、昇降機構41、Y軸方向移動機構42およびX軸方向移動機構43は、いかなる構造の機構でもよく、例えば、送りねじ、ラック&ピニオンギア、サーボモータ、流体圧シリンダなどを利用した任意の機構とすることができる。

【0052】このような分注装置1は、分注ヘッド移動手段4の作動により分注ヘッド3を各試薬容器100と、各反応容器200との間で移動しながら、液体500の仕分け、希釈、混合および滴下などの分注作業を行う。

【0053】以下、分注装置1の作動を、試薬容器100中の液体500を反応容器200に仕分けする場合を例に説明する。

【0054】[1] まず、ノズル300の先端開口302が空中にある状態で、すべての通電部53に所定の電圧で通電する。これにより、すべての体積可変部材52は、体積が増大した状態になる。

【0055】[2] 次いで、分注ヘッド移動手段4を

作動し、ノズル300の先端開口302が試薬容器100中の液体500の液面より下に位置するように分注ヘッド3を移動する。

【0056】[3] この状態で、通電部53に対する通電を解除すると、体積可変部材52の体積が減少することにより、ノズル300内の空気が流出入口511からハウジング51内に吸入され、ノズル300内の圧力が低下する。この圧力低下により、液体500が先端開口302よりノズル300内に吸入される（図2参照）。

【0057】このとき、通電を解除する通電部53の個数を調整することにより、ノズル300内に吸入する液体500の量を調整することができる。すなわち、通電を解除する通電部53の個数が1個の場合には、1個の体積可変部材52の体積減少量に対応した量の液体500がノズル300内に吸入される。そして、通電を解除する通電部53の個数を2個、3個、・・・、14個とすることにより、液体500の吸入量は、1個の通電部53の通電を解除したときに対し概ねその2、3、・・・、14倍となる。このようにして、液体500の吸入量を14段階に調整することができる。

【0058】また、このとき、体積可変部材52が印加電圧をゼロにしても体積が完全には元の大きさ（基準の大きさ）に戻らないような性質のものである場合、すなわち、体積可変部材52の体積変化にヒステリシスがあるようなものである場合には、通電部53に対する通電を解除した後、体積可変部材52の体積が基準の大きさに戻るよう、通電部53に逆方向の電圧を印加するような制御を行うこととしてもよい。また、前記[1]の前に、通電部53にある一定の基準電圧を印加しておき、[1]でこれより高い電圧を通電部53に印加し、[3]で通電部53への印加電圧を前記基準電圧に戻す、というような制御をしてもよく、この制御によりヒステリシスの影響を小さくすることができる。これらのような制御を行うことにより、より精度の高い分注を行うことができる。本明細書中では、上記のように、通電部53に対する通電を解除した後逆方向の電圧を印加する場合や、通電部53への印加電圧をある一定の基準電圧に戻す場合も含めて、単に「通電の解除」と言う。

【0059】このような液体500の吸入動作において、複数の通電部53に対する通電を解除する場合、それらの通電部53に対する通電を同時に解除すると、液体500を高速に吸入することができる。

【0060】また、複数の通電部53に対する通電を解除する場合、各通電部53に対し時間差を置いて通電を解除してもよい。この場合、その時間差を調整することにより、液体500の吸入速度を調整することができる。すなわち、その時間差を長くすると、吸入速度を遅くすることができ、その時間差を短くすると、吸入速度を速くすることができる。

【0061】[4] ノズル300内に液体500を吸入したら、分注ヘッド移動手段4を作動し、分注ヘッド3を反応容器200の位置に移動する。

【0062】[5] 次いで、通電を解除した通電部53に対し、再度、所定の電圧で通電する。これにより、通電された体積可変部材52の体積が増大し、ハウジング51内の空気が流出口511から流出してノズル300内の圧力が増大する。この圧力増大により、ノズル300内の液体500が先端開口302より吐出（排出）される。この吐出された液体500を反応容器200に滴下（落下）させることにより、反応容器200中に付与する。また、吐出された液体500が先端開口302付近に付着した状態になる場合には、分注ヘッド移動手段4を作動してノズル300の先端部を反応容器200の内壁またはその中の液体に接触させることにより、吐出した液体500を反応容器200中に付与することとしてもよい。

【0063】このような液体500の吐出動作の際には、前記の吸入動作のときと同様に、通電する通電部53の個数を調整することにより、吐出する液体500の量を調整することができる。

【0064】また、このような液体500の吐出動作において複数の通電部53に通電する場合、それらの通電部53に対し同時に通電すると、液体500を高速に吐出することができる。また、吐出量や、先端開口302の開口径等の条件によっては、液体500をノズル300から噴射するようにして吐出することもできる。

【0065】また、液体500の吐出動作において複数の通電部53に通電する場合、各通電部53に対し時間差をおいて通電してもよい。この場合、その時間差を調整することにより、液体500の吐出速度を調整することができる。すなわち、その時間差を長くすると、吐出速度を遅くすることができ、その時間差を短くすると、吐出速度を速くすることができる。

【0066】[6] 分注ヘッド3を他の反応容器200に移動して[5]の動作を繰り返すことにより、試薬容器100中の液体500を各反応容器200に仕分けすることができる。

【0067】このように、本発明のポンプ5は、体積可変部材52の体積変化によって流体を吸入、吐出するものであり、機械的な可動部がない。よって、機械的ガタ、バックラッシュなどの悪影響を受けないので、吸入量、吐出量を高い精度で制御（調整）することができる。特に、極めて微量の流体でも高い精度で吸入、吐出することができる。また、構造が簡単で、製造コストの低減にも寄与する。また、可動部がないことから、故障のおそれが少なく、耐久性にも優れる。

【0068】また、このようなポンプ5（ポンプ装置6）を備えた本発明の分注ヘッド3および分注装置1では、分注量を高い精度で制御（調整）することができ、

特に、極めて微量の液体でも高い精度で分注することができる。

【0069】さらに、本実施形態では、複数の体積可変部材52に対しそれぞれ個別に通電部53が設けられており、各体積可変部材52に対しそれぞれ独立して電圧を印加可能になっていることにより、吸入量、吐出量を容易かつ高精度に調整することができる。なお、本発明では、体積可変部材52を複数個設ける場合、その数は、特に限定されず、例えば2～1000個程度とすることができる。体積可変部材52の個数を多くすることにより、吸入量、吐出量を微量から比較的多い量までより広範囲で高精度に調整することができる。

【0070】なお、本発明では、体積可変部材52の設置個数が1個で、吸入量、吐出量が所定の値に定まっているようなものでもよい。また、体積可変部材52が1個の場合でも、通電部53への通電電圧を調整することにより、体積可変部材52の体積変化量を調整することができ、これにより、吸入量、吐出量を調整することもできる。

【0071】また、複数の体積可変部材52が設置されている場合にも、通電部53への通電電圧を調整するようにしてもよい。これにより、吸入量、吐出量をより多段階に精度良く調整することができる。

【0072】また、本発明では、体積可変部材52は、上述した実施形態と逆に、電圧の印加により体積が減少するようなものであってもよい。

【0073】また、本実施形態では、空気（気体）を作動流体として吸入・吐出することにより目的の液体500を分注するものであったが、本発明では、作動流体は、絶縁性の液体でもよい。すなわち、ハウジング51内に絶縁性液体が充填され、流出口511より吸入・吐出する絶縁性液体を介して液体500を分注するものでもよい。また、体積可変部材52および通電部53の表面に絶縁性の被膜を形成したような場合には、作動流体は、絶縁性のない液体でもよい。

【0074】また、本発明では、体積可変部材は、磁場の印加によって（磁歪効果により）体積が変化する物質で構成されたものであってもよい。このような物質としては、特に限定されないが、例えば、Tb-Dy-Fe合金等の各種磁歪材料、超磁歪材料等が挙げられる。この場合、通電部としては、例えば、通電によりこの体積可変部材に磁場を印加するコイルを用いることができる。

【0075】図5は、本発明の分注ヘッドアレイの実施形態を示す斜視図である。以下、この図を参照して本発明の分注ヘッドアレイの実施形態について説明するが、前述した実施形態との相違点を中心に説明し、同様の事項はその説明を省略する。

【0076】図5に示す分注ヘッドアレイ7は、複数個（図示の構成では、16個）の分注ヘッド71を並設し

てなるものである。分注ヘッド71は、その形状が異なること以外は、前記分注ヘッド3と同様である。

【0077】分注ヘッド71におけるポンプのハウジング711は、扁平な直方体状をなしている。ハウジング711内には、複数（多数）の細長い板状の体積可変部材が重ねて配置されている。

【0078】分注ヘッドアレイ7は、このような薄型の分注ヘッド71を複数個その厚さ方向に一列に並設してなるものである。本発明のポンプは、機械的な駆動源が不要な簡単な構造であることから、形状の自由度が高い。よって、このような薄型の分注ヘッド71や、配列ピッチの小さい分注ヘッドアレイ7を容易に実現することができる。

【0079】このような分注ヘッドアレイ7を備えた分注装置によれば、複数箇所に対して一度に分注を行うことができ、例えば、行列状に多数の穴が形成されたマイクロプレート（多穴プレート）に分注を行う際などに、極めて高い効率で迅速に分注を行うことができる。

【0080】図6は、本発明のポンプの他の実施形態を示す縦断面図である。以下、この図を参照して本発明のポンプの他の実施形態について説明するが、前述した実施形態との相違点を中心に説明し、同様の事項はその説明を省略する。

【0081】本実施形態のポンプ5'は、図6中の左側から右側に向かって流体を送出するものである。このポンプ5'は、分注装置に限らず、流体を送出する他の各種の装置に適用することができる。

【0082】ポンプ5'は、前記ポンプ5とほぼ同様の構成になっており、ハウジング51'と、ハウジング51'内に設置された複数の体積可変部材52と、通電により体積可変部材52に電圧を印加する通電部53とを有している。

【0083】ハウジング51'には、流体が流入する流入口512と、流体が流出する流出口513とがそれぞれ設けられている。すなわち、本実施形態では、ハウジング51'に流入口512と流出口513とが別個に形成されている。流入口512に接続された流路14の途中には、逆止弁（逆流防止弁）16が設けられており、流出口513に接続された流路15の途中には、逆止弁（逆流防止弁）17が設けられている。

【0084】ポンプ5'が前記と同様にして作動すると、ポンプ5'は、流入口512より流体を吸入し、流出口513より流体を吐出する。これにより、流路14および15中の流体を図6中の右方向に送出することができる。

【0085】すなわち、前記ポンプ5は、作動流体である空気（気体）を介して目的の液体500を吸入・吐出するものであったが、本実施形態のポンプ5'は、目的の流体を直接に吸入・吐出し、送出するものである。

【0086】ポンプ5'が送出する流体としては、液体

でも気体でもよい。なお、液体の場合には、体積可変部材52および通電部53の表面に絶縁性の被膜が形成されているのが好ましい。

【0087】また、逆止弁16および17は、なくてもよいが、逆止弁16および17の少なくとも一方が設けられているのが好ましい。

【0088】以上、本発明のポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置を図示の実施形態について説明したが、本発明は、これに限定されるものではなく、ポンプ、ポンプ装置、分注ヘッド、分注ヘッドアレイおよび分注装置を構成する各部は、同様の機能を発揮し得る任意の構成のものと置換することができる。また、任意の構成物が付加されていてもよい。

【0089】また、本発明は、1回の吸入／吐出量が比較的多いものから微量なものまで適用することができるが、特に、1回の吸入／吐出量が1ナノリットル～100マイクロリットル程度の微量なものに好適である。

【0090】また、体積可変部材は、板状のものに限らず、棒状、ブロック状など、いかなる形状のものでもよい。また、電圧または磁場を印加されたときの体積可変部材の変形態様もいかなるものでもよい。

【0091】

【発明の効果】以上述べたように、本発明によれば、流体を高い精度で吸入・吐出することができ、特に、微量の流体でも高い精度で吸入・吐出することができる。

【0092】また、簡単な構造で上記効果を達成することができ、製造コストの低減にも寄与する。また、故障のおそれが少なく、耐久性にも優れる。また、流体を高速に吸入・吐出することができる。

【図面の簡単な説明】

【図1】本発明の分注装置の実施形態を示す斜視図である。

【図2】図1に示す分注装置における分注ヘッドおよびノズルを示す縦断面図である。

【図3】図2に示す分注ヘッドにおける体積可変部材を示す斜視図である。

【図4】図1に示す分注装置のブロック図である。

【図5】本発明の分注ヘッドアレイの実施形態を示す斜視図である。

【図6】本発明のポンプの他の実施形態を示す縦断面図である。

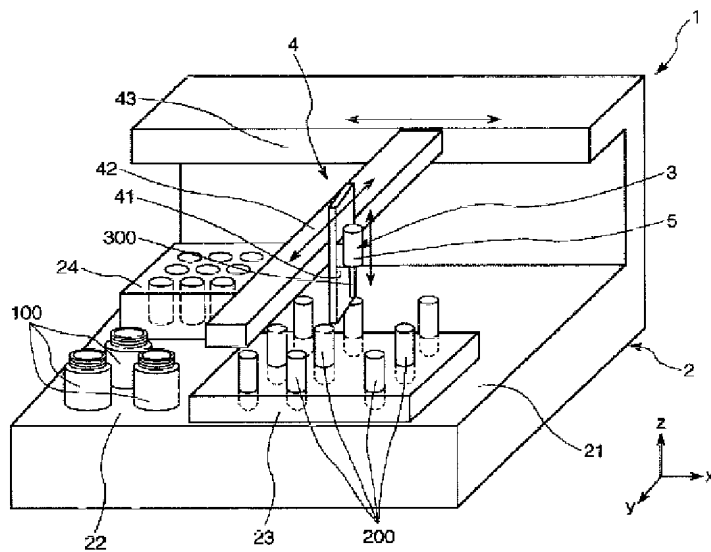
【符号の説明】

1	分注装置
2	装置本体
21	ステージ
22	試薬容器収納部
23	反応容器収納部
24	ノズル収納部
3	分注ヘッド
31	ノズル装着部

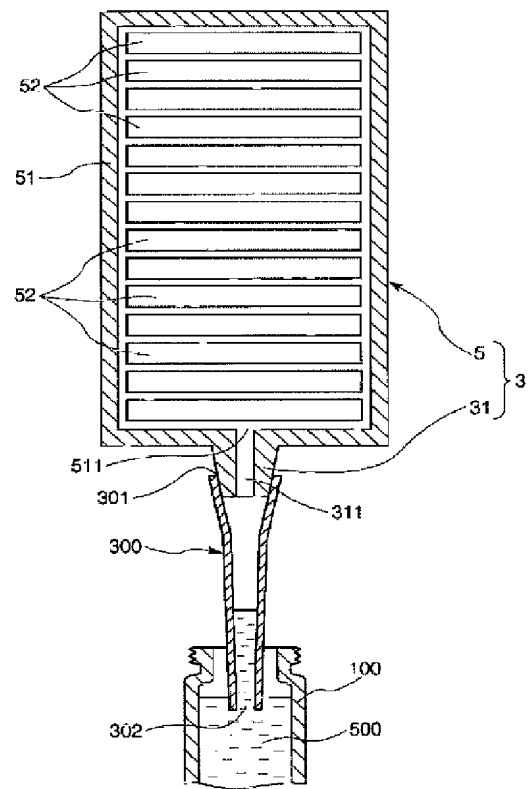
311 流路
4 分注ヘッド移動手段
41 昇降機構
42 Y軸方向移動機構
43 X軸方向移動機構
5、5' ポンプ
51、51'ハウジング
511 流出入口
512 流入口
513 流出口
52 体積可変部材
53 通電部
531、532 電極
533 リード線
6 ポンプ装置
7 分注ヘッドアレイ

71 分注ヘッド
711 ハウジング
11 制御部
12 ポンプ駆動回路
13 ポンプ制御手段
14、15 流路
16、17 逆止弁
18 記憶部
19 入力部
100 試薬容器
200 反応容器
300 ノズル
301 基端開口
302 先端開口
500 液体

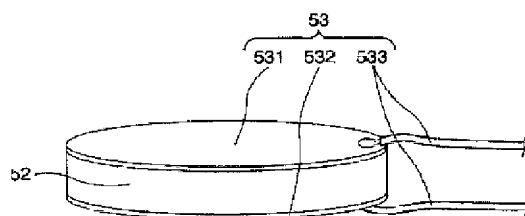
【図1】



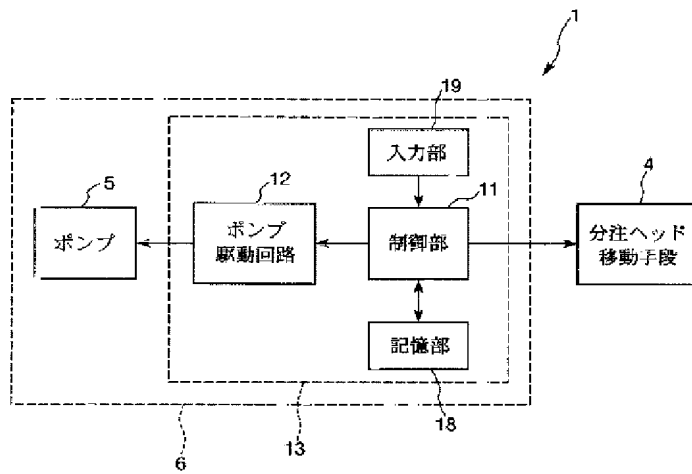
【図2】



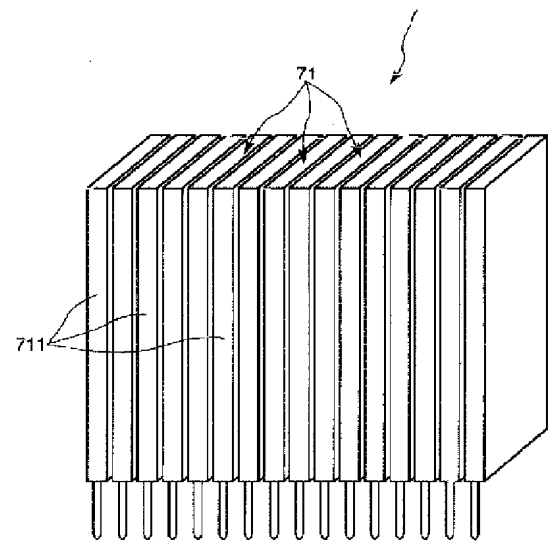
【図3】



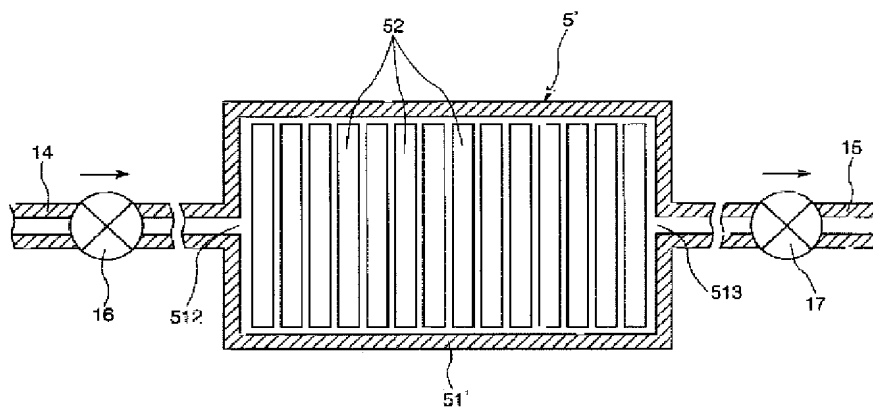
【図4】



【図5】



【図6】



フロントページの続き

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JA10
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